FIRST REPORT

TO THE

Cotton Planters' Convention

OF GEORGIA,

ON THE

AGRICULTURAL RESOURCES

OF GEORGIA,

By JOSEPH JONES, M. D.,

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SUMMARY.

Investigations upon the Chemical Constitution, Geological Distribution, Agricultural and Commercial Value of the Marls, Shell Limestone, Primitive and Older Fossiliferous Limestone, Oyster Shells, Gas Lime, Joint Clay and Kaolin Clay.
Discussions of the Theory of the Action and Mode of Application of Calcareous Manures.
Ancient and Modern Testimonies to the Value of Calcareous Manures.
Investigations upon the Chemical Constitution, Adulteration and Agricultural Value of Commercial Manures.
Discussions of the Relative Values of the Commercial and Native Fertilizers.
Investigations upon the Chemical Constitution, Agricultural Value and Hygienic Relations of the Waters of Georgia.
Investigations upon the Chemical Constitution and Agricultural Value of Swamp Deposits, Vegetable Mould, Deposits of Rivers, Cotton Seed, Stable and Cow-pen Manures.
A Simple, Inexpensive and Effective Method of Preserving the Valuable Gaseous and Soluble Constituents of Stable and Cowpen Manure.
A Simple, but Effective Plan for the Regeneration of the Exhausted Lands of Georgia.
Containing Sixty Original Analyses of the Marls, Limestones, Clays, Waters, River Deposits and Cotton Seed of Georgia, and of Commercial Manures.
One Thousand Analyses of Marls, Limestones, Soils, Commercial and Native Manures, by Eminent American and European Chemists.

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INTRODUCTION.

NECESSITY, OBJECTS AND PLAN OF THE LABORS OF THE CHEMIST OF THE COTTON PLANTERS' CONVENTION OF GEORGIA.

The rate of the decennial increase of the white population of Georgia, has with the exception of a single period, progressively diminished from 1790 to 1860; thus the decennial increase from 1790 to 1800 was 92.25 per cent., from 1800 to 1810, 43.01 per cent., from 1810 to 1820, 30.36 per cent., from 1820 to 1830, 56.57 per cent, from 1830 to 1840, 37.36 per cent., from 1840 to 1850, 27.93 per cent., from 1850 to 1859, 9.56 per cent., and if the same rate of increase has continued up to 1860, the decennial rate of increase between 1850 and 1860 will be 10.62 per cent The increase of the white population of Georgia, between 1850 and 1859 has been very little greater in actual numbers, than the increase between 1790 and 1800, notwithstanding the great difference between the population at the commencement of these periods; thus, in 1790, the white population numbered 52,886, in 1800, 101,678 giving an increase of 48,792, in 10 years, in 1850 the United States census assigned 521,572 as the number of whites in Georgia, whilst the State census of 1859 gives only 571,534 whites, showing an increase in nine years of only 49,964.

The rate of the decennial increase of the free colored population of Georgia, has with slight variations progressively decreased from 1790 to 1859; thus the decennial increase from 1790 to 1800, was 156.03 per cent., from 1800 to 1810, 76.74 per cent., from 1810 to 1820, an actual decrease of 2.1 per cent., from 1820 to 1830 an increase of 41 per cent., from 1830 to 1840, 10.74 per cent., from 1840 to 1850, 6.46 per cent., from 1850 to 1859, 12.31 per cent.

The rate of the decennial increase of the slave population, has with the exception of one period, progressively diminished, from 1790 to 1860; thus the decennial increase from 1790 to 1800 was 102.99 per cent., from 1800 to 1810, 77.12 per cent., from 1810 to 1820, 42.23 per cent., from 1820 to 1830, 45.35 per cent., from 1820 to 1840, 29.15 per cent., 1840 to 1850, 35.85 per cent,, 1850 to 1859, 15.19 per

cent., and if the slave population has advanced at the same rate up to 1860, the decennial increase from 1850 to 1860 will be only 16.85 per cent.

The rate of the decennial increase of the entire population of Georgia has progressively diminished from 1790 to 1860; thus the decennial increase from 1790 to 1800 was 96.37 per cent., from 1800 to 1810, 55.62 per cent., from 1810 to 1820, 35.08 per cent., 1820 to 1830, 51.56 per cent., 1830 to 1840, 33.77 per cent., 1840 to 1850, 31.06 per cent., 1850 to 1859, 13 per cent., and if the same rate of increase has continued up to 1860; the decennial increase from 1850 to 1860, will be 14.44 per cent.

The comparative examination of the population of the counties of of the State of Georgia from 1790 to 1859 reveals the following important facts:

1st. The population of the first settled counties in the South Eastern portion of the State, has remained stationary, in most of the counties for the last 15 years, in some there has been a slight increase; whilst in others there has been an actual decrease of population.

Thus the population of Liberty county in 1790, was 5355, in 1800, 5313, in 1810, 6228, in 1820, 6695, in 1830, 7233, in 1845, 7371, in 1850, 7926, in 1859, 8408; of McIntosh in 1800, 2660, in 1810, 3739, in 1820, 5129, in 1830, 4998, in 1845, 5630, in 1850, 6028, and in 1859, 5583; of Camden in 1790, 305, in 1800, 1681, in 1810, 3941, in 1820, 4342, 1830, 4578, in 1845, 5482, in 1850, 6319, in 1859, 5387; of Glynn in 1790, 413, in 1800, 1874, in 1810, 3,417, in 1820, 3,418, in 1830, 4,567, in 1840, 5,302, in 1845, 4,327, in 1850, 4,933, in 1859, 4,009; of Bryan in 1800, 2,836, in 1810, 2,827, in 1820, 3,021, in 1830, 3,139, in 1845, 3,358, in 1850, 3,424, in 1859, 3,763; of Wayne in 1810, 676, in 1820, 1.010, in 1830, 9,63, in 1845, 1,290, in 1850, 1,499, in 1859, 2,384; of Tatnall, in 1810, 2,206, in 1820, 2,644, in 1830, 2,040, in 1845, 2,508, in 1850, 3,217, in 1859, 3,411; of Telfair, in 1810, 744, in 1820, 2,104, in 1830, 2136, in 1845, 2,753, in 1850, 3,026, in 1859, 2,723; of Bulloch in 1800, 1,913, in 1810, 2,305, in 1820, 2,578, in 1830, 2,587, in 1845, 3,305, in 1850, 4,300, in 1859, 5,545; of Screven in 1800, 3,019, in 1810, 4,477, in 1820, 3,941, in 1830, 4,776, in 1845, 5,822, in 1850. 6,847, in 1859, 7,884; of Effingham in 1790, 2,424, in 1800, 2·077, in 1810, 2,586, in 1820, 3,018, in 1830, 2,924, in 1845, 3,457, in 1850, 3,864, in 1859, 4,606; of Burke, in 1790, 9,467, in 1800, 9,506, in 1810, 10,858, in 1820, 11,577, in 1830, 11,833, in 1845, 13,636, in 1850, 16,100, in 1859, 16,529; of Jefferson in 1800, 5,684, in 1810, 6,111, in 1820, 7,056, in 1830, 7,309, in 1845, 8,306, in 1750, 9,131, in 1859, 10,369.

The population of Chatham is not given, because in this county, is situated the largest city of the state, the increase of which depends especially upon its relations with distant portions of the state, and but secondarily upon local causes, as climate soil and Agriculture.

In examining the progress of the population in this group of counties, it is important to note that those counties which have progressed most steadily in population, and which have reached the highest figure, are those, as Burke and Jefferson, which are situated in the eocene lime formation of Georgia.

2. The population of the earliest settled counties in middle Georgia, has in most cases, progressively decreased for many years past.

Thus the population of Clarke county in 1810, was 7,628; in 1820, 8,767; in 1830, 10,176; in 1845, 10,343; in 1850, 11,119; in 1859, 10.980; of Warren in 1800. 8,329, in 1810, 8.725, in 1820, 10,630, in 1830, 10,946, in 1845, 11,468, in 1850, 12.425, in 1859, 9,676; of Lincoln in 1800, 4,766, in 1810, 4,555, in 1820, 6,458, in 1830, 6,-145, in 1845, 7,899, in 1850, 5,998, in 1859, 5,310; of Franklin in 1790, 1,041, in 1800, 6,860, 1810, 10,815, in 1820, 9,040, in 1830, 10,107, in 1845, 10,030, in 1850, 11,513, in 1859, 7,107; of Oglethorpe, in 1800, 9,780, in 1810, 12,297, in 1820, 14,046, in 1830, 13,-618, in 1840, 10,868, in 1845, 11,001, 1850, 12,259, in 1859, 11,820; of Putnam in 1810. 10,029, 1820, 15,475, in 1830, 13,261, in 1845, 10,939, in 1850, 10,794, in 1859, 10,360; of Wilkes in 1790, 31,500, in 1800, 13,103, in 1810, 14,887, in 1820, 17,607, in 1830, 14,237, in 1845, 11,042, in 1850, 12,107. in 1859 10,510; of Habersham, in 1820, 3,145, in '30, 10,671, in '45, 8.411, in '50, 8,895, in '59, 5,952; of Jasper in 1820, 14,614, in '30, 13,131, in '45, 10,560, in '50, 11,486, in '59, 11,129; of Greene in 1790, 5,405, in 1800, 10,761, in '10, 11,-679, '20, 13.589, in '30, 12,599, in '45, 11,973, in '50, 13,068, in '59, 11,784; of Washington, in 1790, 4,552, in 1800, 10,300, in '10, 9,940, in '20, 10,627, in '30, 9,820, in '40, 10,565, in '45, 11,272, in '50, 11,-766, in '59, 11,516; of Columbia, in 1800, 8,345, in '10, 11,242, in '20, 12,695, in '30, 12,606, in '45, 11,270, in '50, 11,961, in '59, 12,-097; of Richmond (city of Augusta in this county,) in 1790, 11,317, 1800, 5,431, in '20, 8,608, in '30, 11,644, in '45, 14,090, in '50, 16,-246, in '59, 20,107; of Jackson, in 1800, 7,147, in '10, 10,569, in '20, 8,353, in '30, 9,004, in '50, 9,768, in '59, 10,540; of Hall, in 1820, 5,086, in '30, 11,748, in '50, 8,713, in '59, 9,797; of Gwinnett, in '20, 4,589, in '30, 13,289, in '50, 11,257, in '59, 13,223; of Walton in '10, 1,026, in '20, 4,192, in '30, 10,929, in '50, 10,821, in '59, 10,882; of Morgan, in 1810, 8,369, in '20, 13,520, in '30, 12,046, in '50, 10,744, in '59, 9,679; of Jones in '10, 8.597, in '20, 16,570, in '30, 13,345, in '50, 10,224, in '59, 8,609; of Hancock, in in 1800, 14,456, in '10, 13,330, in '20, 12,734, in '30, 11,820, in '40, 9,659, in '45, 10,049, in '50, 11,578, in '59, 12,049.

The population of the newly settled counties of middle and northern Georgia, notwithstanding its rapid increase in the first years of the settlement of this section of the state, is now becoming stationary in some counties, and in a few counties has already commenced to decrease.

Thus the population of Coweta in 1830, was 5,003, in '45, 10,911, in '50, 13,635, in '59, 12,628; of Crawford, in 1830, 5,313, in '40, 8,493, in '50, 8,984, in '59, 7,504; of Henry, in 1830, 10,566, in '45 13,455, in '50, 14,726, in '59, 10,732; of Harris in 1830, 5,105, in '45, 14,138,

in '50, 14,720, in '59, 13,648; of Fayette, in 1830, 5,504, in '45, 7,514, in '50, 8,709, in '59, 7,225; of Pike in 1830, 6,149, in '45, 11,394, in '50, 14,305, in '59, 9,751; of Paulding in '45, 4,439, in '50, 7,039, in '59, 6,175; of Newton in 1830, 11,155, in '45, 12,089, in '50, 13,296, in '59, 14,241; of DeKalb in 1830, 10,042, in '40, 10,467, in '45, 11,-055, in '50, 14,328, in '59, 8,418; of Talliaferro in 1830, 4,934, in '45, 5,801, in '50, 5,146, in '59, 4,808: of Talbot, in 1830, 5,940, in '45 14,192, in '50, 16,534, in '59, 13,816; of Union, in 1845, 5,812, in '50, 7,234, in '59, 4,084; of Upson, in 1830, 7,013, in '45, 9,828, in '50, 9,424, in '59, 10,172; of Meriwether, in 1830, 4,422, in '45, 15,381, in '50, 16,476, in '59, 15,023.

4. The counties of the north-western portion of the state, the geological formations of which are more recent than middle Georgia, and older than those of the cretaceous and tertiary formations of Georgia, have been but recently settled and in most cases are rapidly increasing, and it is therefore at the present time impossible to say what the limits of the population will be, especially as the soil contains more lime than any other portion of Georgia, and appears to be more inexhaustible under culture.

5. The counties of the southwestern portion of the state, embracing the cretaceous and more recent eocene lime formations, like the counties of north-western Georgia have been but recently settled, and are rapidly increasing by emigration from the older counties of the state; and it is impossible at the present time to assign the probable limits of the population with any degree of certainty,

We may however from a careful review of the rapid increase of population, and from a careful consideration of the resources of the soil of north-western and south-western Georgia, affirm that under the same exhausting and reckless system of agriculture which has been pursued in the older counties, the population of these portions of the state will in the course of fifty years, reach its culminating point, and the tide will then flow to the rich lands of newer states.

The exports and imports of Georgia have not increased in a corresponding manner with the population; thus the exports from 1820 to '30, were $46,689,146 and the imports $5,173,224; from 1830 to '40, exports $73,493,949, imports $4,941,252; from 1840 to '50, exports $44,859,125, imports $3,147,915; from 1850 to '58, exports $62,-427,852, imports $4,080,199.

The increase in the yield of Cotton in Georgia has not corresponded with the increase of population; thus the number of bales of Cotton produced in 1824, was 152.735; in 1825, 138,000; in 1826, 190,592; 1827, 233,920; in 1828, 153,749; in 1829, 249,166; in 1830, 253,117; in 1831, 230,502; 1832, 276,437; in 1833, 271,025; in 1834, 258,655; in 1835, 222,670; in 1836, 270,121; in 1837, 262,971; 1838, 304,210; in 1839, 205,112; in 1840, 292,693; in 1841, 148,947; in 1842, 232,271; in 1843, 299,461; in 1844, 255,-597; in 1845, 295,440; in 1846, 194,911; in 1847, 242,789; in 1848, 254,875; in 1849, 391,372; in 1850, 343,635; in 1851, 322,376; in 1852, 325,714; in 1853, 349,490; in 1854, 316,005; in 1855, 378,-694; in 1856, 389,445.

If we examine these facts collectively and endeavor to determine their causes, we will find that the main cause, which is of far greater importance than emigration, changes of climate and seasons, the value of produce and other causes, is that system of Agriculture, which takes for granted that soils are inexhaustible, and which has regarded the interests alone of the acting generation.

The lands of Middle Georgia, which, at the time of their first settlement, were clothed with a dense and magnificent forest, and covered with the accumulated mould of thousands of years, and which yielded most luxuriant and profitable crops of Cotton and Corn to the early cultivators, who imagined that the soils would last forever without either rest or manure, and without any attention to hill-side ditching and plowing, now present the monotonous and dreary spectacle of bald, barren, red clay hills, marred by deep furrows and yawning red gullies.

The same result has followed this system of culture in the southern portions of Georgia. The effects are not so patent to the eye, because the country is level, and because the rivers afford inexhaustible supplies of organic and mineral matters to the Rice plantations.

It remains to be demonstrated whether or not, the fruitful plains of South-western Georgia, and the fertile vallies of North-western Georgia, will share the same fate. The reckless exhaustion of land has been, by no means, confined to Georgia.

When Massachusetts, Connecticut, New York, Rhode Island, Maryland and Virginia were first settled, the same exuberant fertility was attributed to the soils of these old States, which has since characterized those of Georgia, Alabama, Kentucky, Mississippi, Louisiana, Ohio and Illinois. When the older States were first settled, even those portions naturally sterile, were covered with a thick deposit of vegetable mould, and yielded, for a time, abundant crops. Under a reckless and exhausting system of cultivation, this vegetable mould, together with a large portion of the saline ingredients, has been consumed, the crops correspondingly diminished, the land reduced to comparative sterility, and the cultivators of the soil driven to seek virgin soil in new and uncultivated regions. From this course, has section after section of the older States, which once yielded an abundant return, been abandoned by their original possessors and allowed, for a time, to revert back to the original wilderness. The reckless and ignorant exhaustion of the accumulated vegetable and mineral compounds elaborated and stored up by the vegetation of unnumbered ages, has been one of the prime causes of that mighty tide of emigration from the Eastern to the Western and South-western States. Under the same system of culture, these States, in turn, will grow old and barren in a century—under this reckless system of culture, the original thirteen States grew older and more barren in two centuries than Europe, and India, and China after thousands of years of cultivation.

The great questions to be solved by the Agriculturists of Georgia, are: How can the exhausted lands be restored to their primitive state of ertility? How can the new lands of Northern, North-western and of South-western Georgia be preserved in their original state of fertility?

Are the native resources of the State adequate to the regeneration of her exhausted lands, and the permanent preservation of the fertility of her new lands ?

Upon the determination of these questions, will depend the future agricultural, commercial and political progress and importance of Georgia. If they are ignored by the Agriculturists, certain it is that the lands will steadily be exhausted, their value will steadily diminish, the population will as steadily emigrate to more fertile regions, and our State will not attain to that high political and commercial position assigned her in Providence, by her soil, her climate and her productions. Questions of such magnitude and importance cannot be settled in a day or in a year.

With a population of more than one million, distributed over fifty-eight thousand square miles—with a territory three hundred and twenty-two miles in length, from north to south, extending from the mild, almost tropical climate of the Atlantic coast, to the cool, bracing climate of the Blue Ridge Mountains; two hundred and twenty-four miles in breadth, from east to west, watered by fifty streams, which deserve, and hold the names of rivers—with a territory embracing almost every geological formation, from the oldest to the most recent, found upon the Western continent; the primitive and metamorphic, non-fossiliferous strata of Middle and Northern Georgia, with its inexhaustible mineral resources; the older fossiliferous formations of North-western Georgia, resembling the celebrated wheat district of New York, with its inexhaustible deposits of limestone and other minerals useful in agriculture and the arts; the cretaceous formation of Western Georgia, with its inexhaustible beds of green sand and marl; the Eocene Lime formatieu of Southern and South-western Georgia, with its inexhaustible supplies of Lime and Phosphoric Acid; the rich alluvial and diluvial plains and river bottoms of Southern Georgia—with a territory embracing every variety of soil suitable to the growth and culture of every important agricultural product, and yielding almost every mineral useful in the arts and in agriculture, Georgia requires the vigorous efforts of many men and the earnest co-operation of all her citizens in the attempt to develope her agricultural resources.

The present Report to the Cotton Planters' Convention should, therefore, be considered as the commencement of labors in the right direction, which will require years of toil for their completion.

We have called the attention of the Cotton Planters' Convention, first, to the inexhaustible beds of Marl and Limestone of Georgia, because it is the almost universal experience of Agriculturists, that Lime is the basis of good husbandry; secondly, to the chemical composition and adulterations of Commercial manures, because there appears to be a growing disposition with Planters to use them as a source of fertility to their lands, several hundred thousand dollars worth of Commercial fertilizers having been purchased by the planters of Georgia during the past year; and thirdly, to the native sources of organic and inorganic compounds necessary to restore the equilibrium and preserve the land in a permanent state of fertility, because the use of Lime, without manure,

impoverishes the soil, and because we believe that any system of agriculture which relies upon sources other than those furnished by the State, must necessarily prove a failure.

In succeeding reports the following subjects, in addition to those now discussed, will receive attention:

1. The Soils of Georgia—their Chemical and Physical Properties and Geographical Distribution.

2. The Climate of Georgia—its Relations to Soils, Plants and Animals, and to the Health and Diseases of its Inhabitants.

3. The Mineral Resources of Georgia—their Agricultural and Commercial Relations.

4. The Chemical Constitution, Physical and Physiological Relations of the Principal Agricultural Plants and Productions of Georgia.

5. The Methods of Preparing the various Minerals useful in Agriculture, as Gypsum, Sulphuric Acid, Nitric Acid, Hydrochloric Acid, and Salt from Sea Water.

6. The Diseases of Georgia—their Geographical Distribution and Relations to Soil and Climate, with the Mortuary Statistics of various sections of the State, so arranged that the value of Slave Pproperty, as regulated by the diseases and rates of increase, may be determined.

7. The Geographical Distribution, Specific Characters, and Agricultural Relations, of the Plants and Animals of Georgia.

8. The Aboriginal Remains of Georgia.—This is an interesting field of research, and as yet but partially explored.

We hope that the present humble commencement of this work will be received with due allowance by the Planters of Georgia; for from the first inception of the Agricultural survey, to the present time, the expenses and labors of chemical research and field explorations, and the expenses of printing, have fallen upon the private resources of the Chemist of the Convention. It has been, therefore, out of his power to employ assistants to conduct the survey upon the scale which its importance demands.

In the present report, we present 60 original analyses, which are numbered continuously, together with more than one thousand analyses, by reliable chemists, of Soils, Marls, Commercial Manures, Vegetable and Animal substances related to Agriculture, which are not numbered. We make this statement that the original and the quoted analyses may be distinguished at a glance. Besides this difference, the authority for each analysis, by American and European Chemists, will be found either at the foot of the page or at the head of the tables.

No. 90 Green Street,
Augusta, Ga.,

October, 20, 1860.

CHAPTER .I.

GEOLOGICAL POSITION AND EXTENT

OF THE

TERTIARY LIME FORMATION OF GEORGIA.

CHAPTER I.

Geological Position and Extent of the Tertiary Lime Formation of Georgia.

The Shell Limestone of Georgia belongs to the Eocene, the lowest divison of the Tertiary formation.

This formation is called Eocene, because it is the *dawn* of the existing state of the animated creation, for whilst in the more recent formations, the Pliocene and Miocene, which in the Southern portions of Virginia, North Carolina, South Carolina, Georgia, Alabama and other States rest upon the Eocene, many of the fossil species have been identified with species now living in the seas and oceans, in the Eocene formation on the other hand, but very few of the fossils have been identified with living species.

The fossils characteristic of this formation will be noticed in the general Report on the soils and geological formations of Georgia, which I hope to present to the Cotton Planters Convention at an early day—at present we will merely state that it is exceedingly rich in fossil shells, corals, bones and teeth of Sharks and other extinct vertebrate and invertebrate animals—300 species of shells have been discovered at a single locality at Claiborne Alabama, and described by Mr. Isaac Lea and Mr. Conrad of Philadelphia, and in Europe more than twelve hundred distinct species of shells have been discovered in this formation.

The Cretaceous and Eocene formations underlie the great Atlantic slope or low region (called the Alluvial Plain by

many writers) extending from Long Island to the Eastern Shore of the Gulf of Mexico. The Eocene formation crops out, or has been laid bare, at various localities as Wilmington, North Carolina, on the Santee and Cooper Rivers, Stoudenmire Creek at Eutaw and many other localities in South Carolina, at Shell Bluff, Stony Bluff, Mill Haven, Jacksonboro, Briar Creek, Paramour's Hill, Millen, on the Ogeechee in Burke Co., Tennille, Washington Co., below Columbus Ga., Eufaula and Claiborne, Ala., and many other localities. These localities are mentioned in a regular series from North East to South West. This list which might be greatly enlarged will serve our present purpose, in illustrating the wide distribution of this shell limestone formation. Accompanying the full report to the Cotton Panters Convention we hope to present a Map showing the distribution and relations of this formation.

The wide distribution and inexhaustible stores of the Eocene formation in South Carolina, Georgia, Alabama, Mississippi and other States renders a knowledge of its chemical constitution of the greatest value to the Agriculturist.

For the present we have selected Burke and Washington Counties for two reasons:

1st. They represent a large planting interest, 2d. They are intersected by Railroads, which can distribute the Marl and Shell-limestone to all parts of the State for agricultural and building purposes. In succeeding Reports and in the General Reports to the Convention we hope to be able to present the Chemical Constitution and Agricultural value of the Marls and Shell limestone of every county in Georgia, which possesses these deposits.

CHAPTER II.

CHEMICAL EXAMINATION

OF THE

MARLS OF BURKE CO.

CHAPTER II.

II. Chemical Examination of the Marls of Burke Co., Georgia.

No. 1 Green Marl.

This specimen was obtained upon the plantation of J. V. Jones, Esq., 6 miles East of the 90 mile station, Central Railroad.

The Marl is composed of a mixture of Green silicate of Alumina and Iron, Silicious Sand and Shells.

Section above the bed of Marl.

Sandy Soil - - - - - -	2 feet.
Yellow Clay and sand - - -	3 "
Joint Clay - - - -	35 "
Bed of Green Marl - - -	Undetermined.

The bed of Green Marl is found 40 feet beneath the surface and extends downwards to an unknown depth.

ANALYSIS NO. 1.—GREEN MARL.

		100 parts contain....	100 pounds contain	1 Ton of 2000 pounds contain.........	100 bushels contain pounds..........	200 bushels contain pounds..........	300 bushels contain pounds	400 bushels contain pounds..........	500 bushels contain pounds..........	1000 bushels contain pounds..........
Carbonate of Lime 43,435	Lime..........	24.282	242.820	485.640	2428.	4856	7284	9712	12141.	24282.
	Carbonic Acid..	19.153	191.530	383.060	1915.	3830.	5745	7661.	9576.	19152
Phosphate of Lime 3,649	Lime..........	1.972	19.720	39.440	197.	394.	591.	788	986.0	1972.
	Phosphoric acid	1.667	16.770	33.540	167.	335.	503.	670.	838.5	1677.
Carbonate of Magnesia....................		0.27	2.700	5.400	27.	54.	81.	108.	135.	270.
Sulphate of Lime..........................		trace	—	—	—	—	—	—	—	—
Sulphuric Acid............................		trace	—	—	—	—	—	—	—	—
Chlorides.................................		0.014	0.140	0.280	1.4	2.8	4.2	5.6	7.0	14.
Alumina and Silicates of Iron.............		7.196	71.960	143.92	719.	1439.	2158	2876	3598.	7196.
Insoluble Silicates.......................		31,941	319.410	638,820	3194.	6388	9582	12776	15970.	31941.
Silicious Sand............................		8.055	80.550	161.10	805.	1601.	2415.	32222.	4027.	8050.
Water as Moisture.........................		5.714	57.140	114.28	571.	1142.	1714.	2285.	2857.	5714.

The Green color of this Marl is due to the presence of Silicate of Iron.

This Marl will yield 33½ pounds of Phosphoric Acid to the ton of 2000 pounds.

Each ton of this Marl contains 73 pounds of Phosphate of Lime (Bone Earth)—If now we assume that the Phosphate of Lime is worth 22 cts. per pound, then this constituent alone would be worth $1.46 per ton. The Carbonate

of Lime is also valuable as a fertilizer, as are also the Insoluble Silicates which contain small quantities of Soda and Potassa—and will during their slow decomposition yield them to the soil. At a moderate calculation this Marl is worth $2 per ton to the agriculturist. One hundred bushels of the green marl contains four times more phosphoric acid, and as a necessary consequence, four times more phosphate of lime, than one hundred pounds of Phosphatic and Peruvian guano, or of any other commercial fertilizer.

No. 2 Yellow Marl.

From well near the Methodist Church, 5 miles east of 90 mile station Central Railroad, on the land of J. V. Jones, Esq.

This Marl is composed of yellow clay and shells. The bed lies 30 feet beneath the surface in contact above with joint clay and rests below upon hard shell limestone and is 2 feet thick.

ANALYSIS 2.—YELLOW MARL.

		100 parts contain	100 pounds contain	1 Ton of 2000 pounds contain..........	100 bushels contain pounds..........	200 bushels contain pounds..........	300 bushels contain pounds..........	400 bushels contain pounds..........	500 bushels contain pounds..........	1000 bushels contain pounds..........
Carbonate of Lime 43.023	Lime............	24.993	249.930	499.860	2499.	4998	7497.	9997	12496	24993.
	Carbonic Acid...	18.030	180.300	360.600	1803	3606	54091	7212	9015	18030.
Phosphate of Lime 6.465	Lime............	3.494	34.940	69.880	349.4	698.8	1048.2	1397.6	1747.0	3494.
	Phosphoric Acid.	2.971	29.710	59.420	297.1	594.2	891.3	1188.4	1485.5	2971.
Carbonate of Magnesia..........................		0.841	8.410	16,820	* 84.	168.	252.	336.	420.	841.
Sulphate of Lime..............................		0.002	0.020	0.040	0.2	0.4	0.6	0.8	1.0	2.
Sulphuric Acid................................		0.001	0.010	0.020	0.1	0.2	0.3	0.4	0.5	1.
Chlorides.....................................		0.010	0.100	0.200	1.0	2.0	3.0	4.0	5.0	10.
Oxide of Iron.................................		0,265	2,650	5.300	26.	53.	79.	105.	132.	265.
Silicates Insoluble in Hydrochloric Acid.....		40.178	400.780	803.560	4017	8035.	12053.	16071	20089.	40178.
Silicious Sand................................		5.620	56.200	112.400	562.	1124.	1686.	2248.	2810.	5620.
Water as Moisture.............................		3,100	31,000	62.000	310	620.	930	1240	1550	3100.

This Marl will yield to the Ton of 2000 pounds,

Carbonate of Lime	- - -	860.460 pounds.
Phosphate of Lime	- - -	129.300 "
Phosphoric Acid	- - - -	59.420 "

This Marl will prove a most valuable fertilizer to all soils and especially to sandy soils, on account of the insoluble silicates, (clay,) as well as on account of the ingredients mentioned above. One hundred bushels of the yellow marl contain eight times more Phosphate of Lime than one hundred pounds of any known Guano or manufactured manure.

It would be perfectly safe to apply one hundred pounds of these marls to any land in Georgia, and if the lands be newly cleared and rich in organic matters, we might double and treble the amount.

The experience of Senator Hammond, of South Carolina, and others, have rendered it at least probable that the lands of South Carolina and Georgia will not bear as heavy applications of marl as the lands of England, Virginia and Maryland, and hence I would not, until careful experiments have determined the exact amount of marl which is sufficient for our lands in Georgia, recommend the application of these green and yellow marls, upon sandy and cultivated lands, in larger quantities than two hundred bushels to the acre.

When I have completed the chemical analyses of the soils of Georgia, and have elaborated and finished my investigations upon the climate of Georgia, and its relations to the soil and vegetation, I hope to be able to speak with more precision.

It is, nevertheless, evident, that even with this small amount to each acre, the marls of Georgia will furnish far more Phosphoric Acid and Phosphate of Lime than a corresponding application of the most expensive commercial fertilizers. In making this comparison, we have impartially compared the yellow and green marls with the very best fertilizers in the market.

No. 3 White Shell Marl or Limestone.

Well at the Methodist Church—land of J. V. Jones, Esq. This specimen was taken from a bed of conglomerated fossil shells, lying immediately beneath the Yellow Marl No. 2.

SECTION.

Sandy Surface Soil - - - - -	2 feet.
Yellow Sand and Clay - - - -	3 "
Joint Clay - - - - - - -	25 "
Bed of Yellow Marl No. 2 - - -	3 "
White Shell conglomerate - -	undetermined.

This bed of fossil shells lies 33 feet beneath the surface of the soil, Joint Clay and Yellow Marl, and extends downwards to an unknown depth, probably for more than 100 feet. When pulverised it resembles in appearance slaked lime.

ANALYSIS NO. 11.—WHITE SHELL LIMESTONE.

		100 parts contain	1000 pounds contain pounds,..	1 Ton of 2000 pounds contain pounds,.......	100 bushels contain pounds,..	200 bushels con tain pounds...	300 bushels contain pounds ..	400 bushels contain pounds...	500 bushels contain pounds...	1000 bushels contain pounds,...
Carbonate of Lime 87.742,	Lime,..........	49.192	491.920	983.840	4919.	9838.	14757.	19676.	24596.	49192.
	Carbonic Acid..	38.650	386.500	773.100	3865.	7730.	11595.	15460.	19325.	38650.
Phosphate of Lime, 0.933,	Lime,.........	0.506	5.060	10.120	50.6	101.1	151.8	202.4	253.0	506.
	Phosphoric Acid,	0.427	4.270	8.540	42.7	85.4	128.1	170.8	213.5	427.
Carbonate of Magnesia,..................		0.770	1.700	3.400	77.	154.	231.	308.	385.	770.
Sulphate of Lime.......................		0.103	1.030	2.060	10.3	20.6	30.9	41.2	51.5	103.
Chlorides,.......................... ...		0.005	0.050	0.100	0.5	1.0	1.5	2.0	2.5	5.
Alumina and Oxide of Iron...............		0.266	2.660	5.320	26.6	53.2	79.8	106.4	133.0	266.
Silicates insoluble in Hydrochloric Acid......		4.552	45.520	91.040	455.	910.	1365.	1820.	2276.	4552.
Silicious Sand,........................		4.062	40.620	31.240	406.	812.	1218.	1624.	2031.	4062.
Water as Moisture,......................		0.117	1.170	2.340	11.7	23.4	35.1	46.8	58.5	117.6

One ton of this Shell Limestone will yield 1756.840 pounds of Carbonate of Lime and when burned 983.040 pounds of lime. It is therefore valuable for architectural as well as agricultural purposes.

*No. 4—Soft White Shell Marl.**

From well near negro quarters on the Plantation of J. V. Jones, Esq., 48 feet beneath the surface of the earth. This bed of Marl is much softer than those just described and the lumps crumble upon the slightest touch—when pulverized it presents a perfectly white appearance and resembles shell lime.

No. 5. Bluish Black Marl.†

This bed of Marl lies in a dense swamp upon the South side of Bluck-head Creek, 13 miles from the 90 mile station Central Railroad and 11 miles from Waynesboro. The land is owned by Capt. Matthew McCullers. This specimen was taken from beneath the roots of a large water oak which had been overturned by a storm.

The trees in this swamp are as large and luxurious as any I have ever seen in this section of the country. The roots of immense trees penetrated this marl in every direction—thus showing that it was favorable to vegetable growth. The hills around were sandy and appeared to be much exhausted by long culture. This Marl or more properly calcareous earth conisted chiefly of Blue Clay in which small fragments of shells and Carbonate of Lime were imbedded, and appeared to have resulted from the washings of the surrounding hills which are composed of sandy soil, joint clay beneath the sandy soil and shell limestone beneath the joint clay; and from sediment (mud, particles of shells, Carbonate of Lime, sand and organic matters) deposited from the waters of Buck-head Creek.

***See Analysis 4 on next page.**

†See Analysis 5 on page 13.

ANALYSIS NO. 4.—WHITE SHELL MARL.

	100 parts contain	1000 pounds contain pounds,..	1 Ton of 2000 pounds contain pounds,......	100 bushels contain pounds,...	200 bushels contain pounds,..	300 bushels contain pounds,..	400 bushels contain pounds,..	500 bushels contain pounds,..
Carbonate of L'me, 71.932, { Lime................	40.282	402.820	805.640	4028.	8056.	12084.	16112.	20140.
Carbonate of L'me, 71.932, { Carbonic Acid,.......	31.650	316.500	633.000	3165.	6330.	9495.	12660.	15825.
Phosphate of Lime, 0.426 { Lime.................	.0230	2.300	4.600	23.	46.	69.	92.	115.
Phosphate of Lime, 0.426 { Phosphoric Acid,........	0.196	1.960	3.920	19.	39.	58.	78.	98.
Carbonate of Magnesia,........................	0.028	0.280	0.560	2.8	5.6	8.4	11.2	14.0
Sulphate of Lime,............................	0.001	0.010	0.020	0.1	0.2	0.3	0.4	0.5
Chlorides,..................................	0.005	0.050	0.100	0.5	1.0	1.5	2.0	2.5
Alumina and Oxide of Iron,....................	1.248	12.480	24.960	124.	249.	373.	498.	624.
Silicates Insoluble in hydrochloric Acid (clay).......	19.062	190.620	381.240	1906.	3812.	5718.	7624.	9530.
Silicious Sand,..............................	5.466	54.660	119.320	546.	1093.	1639.	2186.	2733.
Water as Moisture............................	0.842	8.420	16.840	84.	168.	252.	336.	420.

ANALYSIS NO. 5—BLUISH BLACK MARL OR CALCAREOUS EARTH.

	100 parts contain,....	1000 pounds contain pounds,. .	1 Ton of 2,000 pounds contain pounds,......	100 bushels contain pounds,...	200 bushels contain pounds,..	300 bushels contain pounds,..	400 bushels contain pounds,..	500 bushels contain pounds,..	1000 bushels contain pound.s..
Carbonate of Lime, 9.739, { Lime,........	5.454	54.540	109.080	545.	1090.	1635.	2180.	2725.	5450.
Carbonate of Lime, 9.739, { Carbonic Acid,	4.285	42.850	85.700	428.	856.	1284.	1712.	2140.	4280.
Phosphate of Lime, 0.615, { Lime,....	0.332	3.320	6.640	33.	66.	99.	132.	165.	330.
Phosphate of Lime, 0.615, { Phosphoric Acid,	0.283	2.830	5.660	28.	56.	88.	112.	140.	280.
Carbonate of Magnesia,................	0.030	0.300	0.600	3.	6.	9.	12.	15.	30.
Sulphate of Lime.....................	trace,	—	—	—	—	—	—	—	—
Chlorides,...........	0.120	1.200	2.400	12.	24	36.	48.	60.	120.
Alumina and Oxide of Iron.............	1.140	11.400	22.800	114.	228.	342.	456.	570.	1140.
Organic Matters Ulmic and Humic Acids,&c	1.398	13.980	27.960	139.8	279.6	419.4	559.2	699.0	1398.
Silicates insoluble in hydrochloric Acid.....	32.190	321.900	643.800	3219.	6438.	9657.	12876.	16077.	32190.
Silicious Sand........................	47.173	471.730	943.460	4717.	9434.	13151.	18868.	23585.	47170.
Water as Moisture,.................	6.628	66.280	133.560	662.8	1325.6	1988.4	2651.2	3314.0	6628.

One ton of this Marl or calcareous earth contains 28 pounds of organic matter, 195 pounds of Carbonate of Lime, 12 pounds of Phosphate of Lime and 943 pounds of Insoluble Silicates (Clay). This Marl will therefore prove a valuable fertilizer upon the surrounding sandy lands. It may be applied in much larger quantities than the shell limestone It would be safe to apply 1,000 bushels of this bluish black marl, which occurs on the plantation of Captain Matthew McCullers, in Burke county, to each acre of land, for in this amount we would have only 9,739 pounds of carbonate of lime, intimately mixed with clay.

In this amount we would obtain 610 pounds of Phosphate of Lime. an amount at least twice as great as that contained in a most liberal application of the best guano and commercial manures.

Hence, with truth and reason we may affirm that this bluish black deposit will prove a valuable fertilizing agent to the surrounding exhausted sandy lands. The clay alone will prove a valuable addition to the sandy lands.

No. 6.—Black Swamp Deposit rich in Carbonate of Lime.

Plantation of Capt Matthew McCullers, 300 yards south of Buck-head creek and 260 yards south of deposit No. 5.

This deposit occurs in a dense swamp, and is of recent origin, derived from the washing of the surrounding hills, the vegetable matters of the dense forest, and from the calcareous matters dissolved in the waters of the small stream which issues out of the shell-limestone hills half a mile distant, and which flows through the swamp near this deposit. In wet weather the stream overflows its banks and covers this deposit. This deposit varies from one to three feet in thickness.

One ton of this dried swamp deposit contains 164 pounds of Organic Matter, 135 pounds of Carbonate of Lime, and 16½ pounds of Phosphate of Lime. The large proportion of Organic Matters also assist in rendering this a valuable manure. The value of this swamp deposit, as well as the efficacy of the Shell Marl, is increased by mixing them

together, at the time of their application to the fields. It would be safe to apply one thousand bushels of the black-swamp deposit No. 7, to each acre of land. In this amount we would apply as much Phosphate of Lime, as is contained in one thousand pounds of the very best Phosphatic Guanos, and in addition to this we will apply eight thousand two hundred and twenty-one pounds of organic matters and six thousand eight hundred and eight pounds of Carbonate of Lime.

Although these organic matters are not as soluble, or as valuable sources of ammonia, as the organic matters of Guano, or of animal manures, still they are valuable, for they consist of animalcules, stems, roots and leaves of trees in various stages of decomposition, in addition to various other organic compounds, as humic and ulmic acids. It is well known to every chemist that lime promotes the disintegration and preparation for vegetables, of the most stable and insoluble compounds; hence the deposits of swamps and peat bogs, which are comparatively inert, are readily decomposed and prepared for vegetation by the action of lime. The value of this black swamp deposit, on this very account, will be increased, by mixing it intimately with one-quarter of its weight of pounded lime-stone, or one-twentieth of its weight of lime—this would be easily accomplished on the plantation of Capt. McCullers, where this deposit occurs, for the surrounding hills are composed in great measure of shell Limestone. It should be borne in mind that a less quantity of this mixture should be added to the land. That portion of this swamp deposit, which we designate as insoluble silicates and silicious sand, will of itself alone, be a useful addition to the neighboring sandy lands, for it is composed chiefly of a clay, rich in lime, and contains, also, some soda and potassa.

That the deposits from swamps are useful applications to sandy lands, and greatly increase (when applied in sufficient quantities) the yield of both cotton and corn, I have had most favorable opportunities of observing in my native county, Liberty county, Ga.) upon cotton plantations in the immediate vicinity of the plantation cultivated by my brother and myself; and in this connection I would simply remark, that

I have collected deposits from the salt marshes of the Atlantic coast of Georgia, from the brackish swamps, from the deltas of both salt, brackish and fresh water rivers, and from the fresh water swamps which lie above the tertiary formation, and have been, and am still, engaged in a careful chemical examination of these deposits. We hope to be able to present a report upon these deposits. as well as upon the waters from which they are derived, at an early day, to the Cotton Planters' Convention. In this report the agricultural value of these deposits will be carefully discussed.

ANALYSIS NO 6—BLACK SWAMP DEPOSIT IN NATURAL CONDITION.

		100 parts contain........	1000 pounds contain p'nds	1 Ton of 2,000 pounds contain pounds	100 bushels contain pounds.....	200 bushels contain pounds.. ..	300 bushels contain pounds.....	400 bushels contain pounds.....	500 bushels contain pounds.....	1000 bushels contain pounds.....
Carbonate of Lime, 2,083	Lime..............	1.167	11.670	23.340	116.7	233.4	350.1	468.8	583.5	1167.
	Carbonic Acid.....	0.916	9.160	18.320	91.6	183.2	274.8	366.4	458.0	916.
Phosphate of Lime, 0.292	Lime..............	0.158	1.580	3.160	15.8	31.6	47.4	63.2	79.0	158.
	Phosphoric Acid,..	0.134	1.340	2.680	13.4	26.8	40.2	53.6	67.0	134.
Carbonate of Magnesia........................		0.009	0.090	0.180	0.9	1.8	2.7	3.6	4.5	9.
Sulphate of Lime.............................		trace.								
Organic Matters, Humic and Ulmic Acids, &c., containing Salts of Potassa and Soda.........		2.912	29.120	58.240	291.2	582.4	873.6	1164.8	1456.0	2912.
Oxide of Iron and Alumina....................		1.329	13.290	26.580	132.9	265.8	398.7	531.6	664.5	1329.
Insoluble Silicates and Sand, (chiefly clay)......		28.409	284.090	568.180	2840.9	5681.8	8522.7	11363.6	14204.5	28409.
Water as Moisture............................		64.714	647.140	1294.280	6471.4	12942.8	19414.2	25885.6	32357.0	64714.

This analysis reveals the fact that each ton of the moist swamp deposit contains 1294 pounds of water; this fact shows the necessity of drying this swamp deposit before transportation. Dried at a temperature of 230°, this swamp deposit presented the following composition:

ANALYSIS NO 7—DRY SWAMP DEPOSIT.

		100 parts contain.........	1000 p'ds contain pounds,	1 Ton of 2,000 pounds contain pounds	100 bushels contain pounds.....	200 bushels contain pounds.....	300 bushels contain pounds.....	400 bushels contain pounds.....	500 bushels contain pounds.....	1000 bushels contain pounds.....
Carbonate of Lime, 6.808	Lime..............	3.813	38.130	76.260	381.3	762.	1043.	1524.	1805.	3810.
	Carbonic Acid.....	2.995	29.950	59.900	299.5	599.	899.	1198.	1497.	2990.
Phosphate of Lime, 0.822	Lime..............	0.444	4.440	8.880	44.4	88.	133.	177.	222.	444.
	Phosphoric Acid...	0.378	3.780	7.560	37.8	75.	113.	151.	189.	378.
Carbonate of Magnesia........................		0.029	0.290	0.580	2.9	5.	8.	11.	14.	29.
Sulphate of Lime.............................		trace								
Organic Matters, Humic and Ulmic Acids, &c., containing also Salts of Soda and Potassa....		8.221	82.210	164.420	822.1	1644.	2466.	3288.	4110.	8221.
Oxide of Iron................................		3.766	37.660	75.320	376.6	753.	1189.	1506.	1813.	3766.
Insoluble Silicates and Silicious Sand..........		80.211	802.110	1604.220	8021.1	16042.	24063.	32084.	40.105	80211.

No. 7.—Reddish Brown Marl.

his deposit lies on the edge of the dense swamp in ch the previous deposit was found, 340 yards south of

ANALYSIS 8.—REDDISH BROWN MARL.

	100 parts contain........	1000 pounds contain pounds, ..	1 Ton of 2,000 pounds contain pounds, ...	100 bushels contain pounds,..	200 bushels contain pounds,..	300 bushels contain pounds,..	400 bushels contain pounds,..	500 bushels contain pounds,..	1000 bushels contain pounds...
Carbonate of Lime, 42.389 { Lime, ...	23.738	237.380	474.760	2373.	4647.	7121.	9485.	11869.	23730.
Carbonate of Lime, 42.389 { Carbonic Acid,.	18.651	186.510	373.020	1865.	3730.	5595.	7460.	9325.	18650.
Phosphate of Lime, 0.218 { Lime.........	0.118	1.180	2.360	11.8	23.6	35.4	46.4	59.0	118.
Phosphate of Lime, 0.218 { Phosphoric Acid	0.100	1.000	2.000	10.	20.	30.	40.	50.	100.
Carbonate of Magnesia,..................	0.157	1.570	3.140	15.7	31.4	47.1	72.8	78.5	157.
Sulphate of Lime.....................	trace,								
Chlorides,.........................	trace,								
Oxide of Iron.........................	2.265	22.650	45.300	22.6	453.	679.	906.	1132.	2265.
Silicates insoluble in Hydrochloric Acid (clay)	23.346	233.460	466.920	2234.	4669.	7003.	6338.	11672.	23340.
Silicious Sand........................	22.900	229.000	458.000	2290.	4570.	6870.	9160.	12450.	22900.
Water as Moisture,....................	8.102	81.020	162.040	810.	1620.	2430.	3240.	4050.	8100.

Buck-Head Creek, 290 yards south of Deposit No. 5, and 40 yards east of Deposit No. 6.

This Deposit appears to be recent, resulting from the washing of the surrounding joint clay and shell lime hills.

This Marl presents a yellow and reddish brown color, and contains numerous nodules of oxide of Iron. When pulverised, it resembles some varieties of American Guano.

No. 8.—Reddish Brown Marl. *

Land of Capt. McCullers, near Limestone Spring. This bed of Marl was found at the base of a hill composed of joint clay and shell Limestone, and extended across the bed of a stream which issued out of the Shell Limestone formation, one hundred yards beyond. It is composed of a mixture of yellow and reddish brown clay and fragments of fossil shells.

No. 9.—White Shell Limestone.†

Plantation of Capt. Matthew McCullers, near Limestone Spring. This formation of shell conglomerate is composed of fossil shells and star-fish, and appears to form the greater portion of the surrounding hills. Many of the star-fish are completely filled with crystallized Carbonate of Lime. Many of the shells are encrusted with beautiful crystals of Carbonate of Lime. This specimen was selected from the side of the stream near the Limestone spring.

This stream, like other streams in this limestone region, issues from the base of a hill. The banks of the stream and the sides of the hill are clothed with the magnificent virgin forest, which forms a dense and delightful shade. The water is very cool and as clear as crystal—it fails, however, to quench thirst, and is injurious on account of the large proportion of lime which it contains. We shall present, in our report to the "Cotton Planter's Convention," analyses of these waters, and also point out their relation to disease and their value in agriculture.

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*For Analyses of this Marl in natural and dried condition, see Analyses Nos 9 and 10. †For Analysis see page 21.

ANALYSIS NO. 9—REDDISH BROWN MARL IN NATURAL STATE.

		100 parts contain,....	1000 pounds contain pounds,. .	1 Ton of 2,000 pounds contain pounds,..... ..	100 bushels contain pounds,...	200 bushels contain pounds,..	300 bushels contain pounds,..	400 bushels contain pounds,..	500 bushels contain pounds, ..	1000 bushels contain pound.s..
Carbonate of Lime, 15.473,	Lime,........	8.665	86.650	173.300	866.	1733.	2599.	346.6	4332.	8660.
	Carbonic Acid,	6.808	68.080	136.160	680.	1361.	2042.	272.3	3404.	6808.
Phosphate of Lime, 0.349,	Lime,....	0.188	1.880	3.760	18.8	37.6	56.4	75.2	94.0	188.
	Phosphoric Acid,	0.161	1.610	3.230	16.1	32.2	48.3	64.4	70.5	161.
Carbonate of Magnesia,................		trace,								
Sulphate of Lime......................		trace,								
Sulphuric Acid		trace,								
Chlorides,............		0.086	0.860	1.720	8.6	17.3	25.8	34.4	43.0	86.
Insoluble Silicates, (clay).............. ...		42.662	426.620	853.240	4266.	8532.	12798.	17064.	1733.0	42660.
Silicious Sand........................		16.942	169 420	338.840	1694.	3388.	5082.	6776.	7470.	16940.
Alumina and Oxide of Iron.......		2.005	20.050	40.100	200.	401.	601.	802.	1002.	2005.
Water as Moisture,..................		21.856	218.560	127.120	2185.	4371.	6556.	8742.	10928.	21850.

ANALYSIS NO. 10—REDDISH BROWN MARL DRIED AT 230°.

		100 parts contain	1000 pounds contain pounds,..	1 Ton of 2000 pounds contain pounds,.....	100 bushels contain pounds...	200 bushels contain pounds,..	300 bushels contain pounds,..	400 bushels contain pounds,..	500 bushels contain pounds...	1000 bushels contain pounds,..
Carbonate of Lime, 19.799	Lime,..... ..	11.087	110.870	221.750	1108.	2216.	3326.	4434.	5543.	11087.
	Carbonic Acid	8.712	87.120	174.240	871.	1742.	2613.	3484.	4356.	8712.
Phosphate of Lime 0.446	Lime,........	0.240	2.400	4.800	24.	48.	72.	96.	120.	240.
	Phosphoric Acid	0.206	2.060	4.120	206.	41.2	61.8	82.4	103.0	206.
Carbonate of Magnesia,...............		trace,								
Sulphate of Lime,..................		trace,								
Sulphuric Acid,............		trace,								
Chlorides,...............		0.107	1.070	2.140	10.7	21.4	32.1	42.8	53.5	107.
Insoluble Silicates, (clay).............		54.594	545.940	1091.880	5459.	10918.	16378.	21837.	27297.	54594.
Silicious Sand,......................		21.680	216.800	633.600	2168.	4336.	6504.	8672.	10840.	21680.
Alumina and Oxide of Iron,...........		2.565	256.500	513.000	256.	513.	719.	1026.	1282.	2565.

ANALYSIS NO. 11.—WHITE SHELL LIMESTONE.

		100 parts contain	1000 pounds contain pounds,..	1 Ton of 2000 pounds contain pounds,......	100 bushels contain pounds,..	200 bushels con tain pounds...	300 bushels contain pounds ..	400 bushels contain pounds...	500 bushels contain pounds...	1000 bushels contain pounds,...
Carbonate of Lime 80.075,	Lime,..	44.843	448.430	896.860	4484.	8968.	13452.	18936.	22421.	44843.
	Carbonic Acid..	35.233	352.330	704.760	3523.	7046.	10569.	17092.	17616.	35230.
Phosphate of Lime, 1.181,	Lime,.........	0.637	6.370	12.740	63.7	127.4	191.1	254.8	318.5	637.
	Phosphoric Acid,	0.544	5.440	10.880	54.4	108.8	163.2	217.6	272.0	544.
Carbonate of Magnesia,..................		0.009	0.090	0.180	0.9	1.5	2.7	3.6	4.5	9.
Sulphate of Lime......................		0.004	0.040	0.080	0.4	0.8	1.2	1.6	2.0	4.
Chlorides,......................... ...		0.009	0.090	0.180	0.9	1.8	2.7	3.6	4.5	9.
Oxide of Iron and Alumina...............		0.594	6.940	13.880	69.	138.	218.	277.	357.	694.
Insoluble Silicates, (clay)..................		4.018	40.180	80.360	401.8	803.6	1205.4	1607.2	2009.0	4018.
Silicious Sand,..........................		13.081	130.810	261.620	1308.	2616.	3924.	5232.	6540.	13081.
Water as Moisture,......................		0.681	6.810	13.620	68.	136.	204.	272.	340.	681.

ANALYSIS NO. 12.—WHITE COMPACT SHELL LIMESTONE.

		100 parts contain	1000 pounds contain pounds,..	1 Ton of 2000 pounds contain pounds,......	100 bushels contain pounds,. ..	200 bushels contain pounds,..	300 bushels contain pounds,..	400 bushels contain pounds,..	500 bushels contain pounds,..	1000 bushels contain pounds,..
Carbonate of Lime, 85.285,	Lime........	47.760	477.600	955.200	4776.	9552.	14328.	18004.	23880.	47760.
	Carbonic Acid,	37.525	375.250	751.500	3752.	7505.	11257.	15019.	17762.	37525.
Phosphate of Lime, 0.250	Lime..........	0.135	1.350	2.700	13.5	27.0	40.5	54.0	67.0	135.
	Phosphoric Acid,.	0.115	1.150	2.300	11.5	23.0	34.5	46.0	57.5	115.
Carbonate of Magnesia,..................		2.220	22.200	44.400	222.	444.	666.	888.	1110.	2220.
Sulphate of Lime,.....................		trace.								
Chlorides,............................		0.019	0.190	0.380	1.9	3.8	5.7	7.6	9.5	19.
Insoluble Silicates, (clay)................		0.393	3.930	7.860	39.3	78.6	87.9	157.2	196.5	393.
Silicious Sand,........................		10.708	107.080	214.160	1070.	2141.	3212.	4282.	5354.	10708.
Alumina and Oxide of Iron,.............		0.876	8.760	17.520	87.	175.	262.	350.	438.	876.
Water as Moisture......................		0.214	2.140	4.280	21.	42.	64.	85.	107.	214.

This bed of White Shell conglomerate will yield when burned 955 pounds of Lime to the ton, suitable for building as well as for agriculture.

This specimen, as well as the preceding one, No. 9, was selected from the base of the hill where the formation is exposed, and at this point streams of water issue, bearing down in their course much white sand. From this fact it is reasonable to infer that if the lime rock is taken from the interior of the hill, it will contain much less sand, and will yield proportionally more Lime.

CHAPTER III.

CHEMICAL EXAMINATION

OF THE

SHELL LIMESTONE OF WASHINGTON COUNTY, GA.

CHAPTER III.

Shell Limestone of Washington County, Georgia.

The Central Rail Road passes through the Eocene formation in Screven, Burke, Jefferson and Washington counties, and many fine deposits of Shell Limestone and Marl may be seen along the route, especially in Jefferson and Washington counties. We shall, at present, present the results of our examination of the deposit in Washington county, near the Station Tennille, No. 14, Central Rail Road. We have selected the deposit in this locality for an early examination and report, because it yields Lime of an excellent quality for architectural as well as agricultural purposes, and because it is inexhaustible, containing lime sufficient to supply every planter and architect in Georgia. I am indebted to Samuel O. Franklin, Esq., of Tennille, for the opportunity of examining the durability and finish of the plaster made from this Lime.

The Station Tennille, near where the Shell Limestone is found, is the most elevated point on the Central Rail Road between Savannah and Macon, being 465 feet above tidewater, 244 feet above the station ten miles above; 279 feet above the Oconee River, 12 miles above; 174 feet above Station No. 12, ten miles below; 285 feet above the Ogeechee River, and 168 feet above Macon.

SECTION AT TENNILLE.

Surface soil, vegetable mould, sand and clay,	6 to 18 inches.
Yellow and Red Clay and Sand, . . .	5 feet.
Joint Clay, ...	12 "
Coarse Sand without Clay, ...	22 "
Solid Shell conglomerate, . . .	undetermined.

At the depth of 51 feet, an abundant supply of water is obtained.

Upon the plantation of Mr. Sneed, one mile and a half from Tennille, the Shell Limestone crops out at the surface, and the sides of several hills which I examined were covered with fragments of oyster shells. These shells, bleached by the sun and acted upon by the weather, resembled the shells which cover the surface of the islands of our sea-coast. The surface shells were easily crushed, whilst those lying in the streams, and which had been washed out of the sides of the hills, were of flinty hardness. Beneath the bed of oyster shells is found a solid conglomerate of shells and star fish. In some localities, sharks' teeth, and vertebræ and ribs of cetaceous and various extinct vetebrate animals are found.

The streams have formed subterranean passages through these hills of Shell Limestone.

In some places, it is possible to pass entirely through the hills in the tunnel formed by these streams. The water flowing in these streams is limpid and cool. The beds of the streams where they flow over the solid shell rock, are paved with fossil star-fish, which being harder and more compact than the surrounding shell conglomerate, resist the action of the water, and stand out above the lime rock. In other places where the loose sand accumulates, sharks' teeth and fossil bones are found, having evidently been washed down by the water.

The Shell Limestone can be obtained in inexhaustible quantities from the sides of the hills, without any excavation, and without suffering any inconvenience from an accumulation of water.

No. 10—White Compact Shell Limestone.

From same Deposit as No. 9. This specimen was much more compact and hard than No. 9. The interior of the shells and star-fish were lined with beautiful crystals of Carbonate of Lime.

ANALYSIS NO. 13—SHELL LIMESTONE OF WASHINGTON CO.

		100 parts contain	1000 pounds contain pounds,..	1 Ton of 2000 pounds contain	100 bushels contains pounds..	200 bushels contain pounds,..	300 bushels contain pounds,..	400 bushels contain pounds,..	500 bushels contain pounds ..	1000 bushels contain pounds,..
Carbonate of Lime 92.216	Lime,........	51.860	515.040	1030.080	5186.	10372.	15558.	20744.	25930.	51860.
	Carbonic Acid,.	40.356	403.560	807.120	4035.	8071.	12106.	16142.	20177.	40356.
Phosphate of Lime & Magnesia 0.628	Lime and Magnesia, .	0.328	3.280	6.520	32.8	65.6	98.4	131.2	164.0	328.
	Phosphoric Acid,...	0.298	2.980	5.960	29.8	59.6	89.4	119.2	149.0	298.
Carbonate of Magnesia,................		trace,								
Sulphate of Lime.....................		0.300	3.000	6.000	30.	60.	90.	120.	150.	300.
Chlorides,..........................		0.015	0.300	0.600	1.5	3.0	4.5	6.0	7.5	156.
Oxide of Iron,.......................		trace,								
Alumina,............................		1.170	11.700	23.400	117.	234.	351.	468.	585.	1170.
Silicates, (insoluble in Hydrochloric Acid)..		4.500	45.000	90.000	450.	900.	1350.	1800.	2250.	4500.
Silicious Sand,.......................		0.933	9.330	18.660	73.	186.	279.	373.	466.	930.
Water as Moisture,...................		0.300	3.000	6.000	30.	60.	90.	120.	150.	300.

This Shell Limestone will yield 1030 pounds of excellent Lime to the ton. For agricultural purposes it will yield 1837 pounds of Carbonate of Lime, and 12½ pounds of Phosphate of Lime. It is highly probable that an extended and careful search would result in the discovery of deposits much richer in the Phosphates. We would look for an accumulation of the Phosphate of Lime in those deposits which are rich in the remains of vertebrate animals. We will in the next place consider the relative value, effects and mode of application of the Marls and Shell Limestone of Georgia. It will be impossible upon the present occasion to do more than present general and well established facts and conclusions.

The whole subject will be fully and carefully discussed in the large Report, which we expect to present to the "Cotton Planters' Convention" when the Agricultural Survey is completed.

CHAPTER IV.

COMPARISON OF THE SHELL-LIMESTONE AND MARLS OF GEORGIA WITH THE LIMESTONES AND MARLS OF EUROPE, AND WITH THE LIMESTONES AND MARLS OF MASSACHUSETTS, RHODE ISLAND, SOUTH CAROLINA, ALABAMA, ARKANSAS AND KENTUCKY.

CHAPTER IV.

Comparison of the Shell-Limestone and Marls of Georgia with the Limestones and Marls of Europe, and with the Limestones and Marls of Massachusetts, Rhode Island, South-Carolina, Alabama, Arkansas and Kentucky.

The following tables will present comparative views of the chemical constitution of the Limestones and Marls of Europe, and of several States where similar deposits have been carefully examined and analyzed by reliable chemists.

In the selection of the materials for the tables of the chemical constituents of the Limestones and Marls of Europe, and of the United States, I have impartially chosen the results obtained by the most reliable observers, and have carefully stated not only the observer's name, but also the titles of the works in which the results were originally published.

In the construction of these Tables I have made no omissions, but have embodied all the results obtained by each observer. These are not, therefore, selected observations, isolated, and partial, but entire series of observations, conducted by the various chemists named. I believe that in this way alone, can fair and impartial comparisons be instituted between the chemical constituents of the Lime-formations of Georgia, and of other parts of the United States and of Europe. We are fully aware that many of the results embodied in these

Tables, relate to formations of different Geological ages, from those of the Eocene of Georgia; and this is precisely one of the results which we wish to accomplish. By this comparison we wish to present in one general view, the chemical constitution of the Lime-formations of various Geological ages.

Every one will admit that this is the only just way of testing the relative value of the Shell-limestone and Marls of Georgia.

TABLE I.—Chemical Constitution of the Shell-Limestone of Georgia, showing the percentage of the various ingredients.

ONE HUNDRED PARTS CONTAIN.

	Near Tennille, Washington co. plantation of Mr. Sneed...	White Shell Limestone, Burke co. 6 miles east of Central R. R. plantation of J. V. Jones, Esq.	White Shell-Limestone, Burke co. 6 miles east of Central R. R. plantation of J. V. Jones, Esq.	White Shell Limestone, Burke co. 12 miles east of Central R.R. plantation of Capt. M. McCullers	White Shell-Limestone, Burke co. 12 miles east of Central R.R. plantation of Capt. M. McCullers
Carbonate of Lime	92.21	87.74	71.93	80.07	85 285
Percentage of Quick-lime	51.860	49.192	40.282	44.843	47·760
Phosphates of Lime and Magnesia	0.628	0.933	0.426	1.181	0·250
Percentage of Lime in the Phosphates	0.328	0.506	0.230	0.637	0.135
do. Phosphoric Acid do.	0.298	0.427	0.196	0.544	0.115
Carbonate of Magnesia	Trace	0.770	0.028	0.009	2.220
Sulphate of Lime	0.300	0.103	0·001	0.004	Trace
Chlorides	0.015	0.005	0.005	0.009	0.019
Oxide of Iron	Trace	.....	.....	.....	.....
Alumina	1.170	.....	.....	.....	.....
Oxide of Iron and Alumina	.....	0.266	1.248	0.694	0.876
Silicates insoluble in Hydrochloric Acid	4.500	4.552	19.062	4.018	0.393
Silicous sand	0.933	4.062	5.466	13.081	0.708
Water as moisture	0.300	0.117	0.842	0.681	0.214

TABLE 2.—Chemical Constitution of the Marls of Georgia, showing the percentage of the constituents.

	Green Marls, Burke county, 6 miles east of Central Rail Road, plantation of J. V. Jones, Esq.	Yellow Marl, Burke co., 5 miles east of Central Rail Road, plantation of J. V. Jones, Esq.	Bluish-Black Marl, plantation of Capt. Matthew McCullers, Burke co. 12 miles east of Central R. R.	Black Swamp Deposit, in natural condition, plantation of Capt. Matthew McCullers, 12 miles east of Central Rail Road	Dry Swamp Deposit, plantation of Capt. Matthew McCullers, Burke county, 12 miles east of C. R. R.	Reddish Brown Marl, Buckhead creek, plantation of Capt. McCullers, Burke county, Ga.	Reddish Brown Marl in natural state, Buckhead creek, plantation Capt. McCullers, Burke county	Reddish brown Marl, Buckhead creek, plantation of Capt. McCullers, Burke county
Carbonate of Lime	43.435	43.023	9.739	2.083	6.808	42.389	15.473	19.799
Percent. of Quick-Lime	24.282	29.993	5.454	1.167	3.812	23.738	8.665	11.087
Phosphate of Lime	3.649	6.465	0.615	0.292	0.822	0.218	0.348	0.446
Percentage of Lime in the Phosphates	1.972	3 494	0.332	0.158	0.444	0.118	0.188	0.240
Per centage of Phosphoric Acid	1.677	2.971	0.283	0.134	0.378	0.100	0.161	0.206
Carb. of Magnesia	0.270	0.841	0.030	0.009	0.029	0.157	trace	trace
Sulphate of Lime	trace	0.002	trace	trace	trace	trace	trace	trace
Sulphuric Acid	trace	0.001	trace	trace	trace	trace	trace	trace
Chlorides	0.014	0.010	0.120	——	——	trace	0.086	0.107
Organic Matters. (Humic and Ulmic Acids, &c.	——	——	1.398	2.912	8.221	——	——	——
Oxide of Iron and Alumnia	7.196	0.265	1.140	1.329	3.766	2.265	2.005	2.565
Silicates Insoluble in Hydrochloric Acid	31.941	40.178	32.190	} 28·409	80.211	23.346	42.662	54.594
Silicious Sand	8.055	5.620	47.170	——	——	22.900	16.942	21 680
Water as Moisture,	5.714	3.100	6.628	64,714	——	8.102	21.856	——

Table 3.—Chemical Constitution of European Limestones.*

100 PARTS CONTAIN.

	Carbonate of Lime.....	Carbonate of Magnesia..	Alumina.....	InsolubleClay
Near Innsbruck	57.10	40.28	2.12	0.43
do do	52.69	39.00	7.20	1.20
Kahl on the Spessart........	49.20	37.30	5.60	7.80
do do do	50.40	39.00	3.50	8.00
Annaberg, Lower Austria...	88.00	8.37	7.82	0.59
Muthmannsdorf, do	89.60	3.70	1.60	5.00
Grolsbach, do	88.00	5.00	2.20	4.80
do do	88.40	5.10	3.00	3.60
Ranek, Lower Austria......	84.40	5.88	3.60	14.00
do do do	83.60	5.88	2.00	16.00
Eppan in the Tyrol........	85.60	4.33	3.17	6.20
Rudolstadt in Thuringa....	95.40	3.30	tra.	2.00
do do	92.80	2.98	3.20	2.00
Ilmenau, (Stinkstein)......	92.20	2.90	3.50	2.40
do do	90.80	2.80	3.20	4.00
Parternion in Carinthia....	91.80	4.10	3.20	0.80
do do	90.00	4.90	4.00	1.10
Seisser Alp. Tyrol..........	81.60	3.00	6.40	10.80
do do do	80.00	3.20	7.20	14.00
St, Triphan in Switzerland..	90.40	4.14	1.80	2.80
do do do	90.40	3.56	2.00	3.60
Roos. Moos-Alm, near seed.	95.00	2.40	1.66	—
Steinabrunn, Lower Austria,	95.00	2.27	1.66	—
Castle-Rock, at Staatz, do	94.00	2.77	3.06	—
Hottinger Alp..............	97.45	2.20	tra.	—
Innsbruck..................	97.00	2.86	tra.	—
Island of Lessind, Dalmatia	94.00	2.42	2.00	0.80
Mundi-Rock in the Tyrol..	96.80	2.80	1.20	—
Predazzo, in the Tyrol......	57.00	39.68	4.00	—
Predazzo, in the Tyrol......	58.70	39.20	2.00	—
From Tivoli, near Rome....	94.40	2.18	4.00	—
Chumlis, above Wyssenburg, in Switzerland	94.40	2.00	1.60	2.40
Untersburg, near Salzburg..	94.00	2.00	4.00	—
Nickolsburg in Moravia....	60.40	36.80	3.60	—
do do do	58.60	37.21	2.60	—
Great Oetscher, Austria....	87.60	1.90	6.80	4.00
King's Tombs, near Thebes	89.00	2.07	3.20	5.60
Gravesend, in Kent.........	90.60	2.07	3.00	3.40
Island of Rugen.............	91.20	2.07	3.00	1.80
Meudon, near Paris..........	92.40	2.11	2.40	2.40
do do.	91.40	2.11	2.80	2.80
Island of Heligoland........	94.00	2.17	1.20	2.00
Louisburg near Aix-la-Chapel	79.60	1.72	2.00	15.20
Lewes, near Brighton......	88.00	1.80	4.00	6.28
Anerbach.....................	94.80	1.17	2.40	2.00
Algen, in the Gastien Valley	91.20	1.32	2.80	4.00
Hiesberg, near Melk, Austria	89.60	1.49	5.00	4.00
Koflach, in Styria..........	54.12	42.60	1.60	2.00
Brunnam Walde.............	48.40	32.47	3.20	4.40
Niesen Chain	79.20	1.45	2.00	18.00
Wimis Bridge, in the Grisons	76.00	1.4[illegible]	6.40	18.80
Fromme in Saxony........	59.20	1.17	1.60	41.60
Stuttgart	66.00	1.44	2.40	30.00
Western Swiss Alps........	64.00	1.90	2.40	32.00
do do do.........	66.60	1.78	1.60	30.80

Table 4.—Chemical Composition of European Marls.*

100 PARTS CONTAIN.

	Luneburg, Powdery Marl, ...	Osnabruck, Stony Marl, ...	Magdeburg, Clayey Marl, ...	Brunswick, Loamy,	Wesermarsh, Powdery, ...	Brunswick, Stony,
Carbonate of Lime,...............	85.50	35 00	18.20	18.10	8.20	13.30
Carbonate of Magnesia,............	1.35	0.90	3.80	1.50	3.00	2.60
Phosphate of Lime,................	2.30	0.50	0.50	0.70	1.20	1.20
Nitrate of Lime,..................	0 01					
Organic Matter,...................	0 60	20 50				
Sulphate of Lime. Gypsum,........	0.06	0.90	2 10	0.10	0.50	trace.
Cloride of Sodium, Common Salt,.	0.03	trace.	trace.	trace.	0.10	trace.
Potash and Soda, combined with Silica,........................	0.05	trace.	1.60	0.80	0.70	0.20
Alumina,....	0.40	10.00	8 40	1.90	3.10	4.0
Oxide of Iron,....................	4.20	1.90	6 70	3.20	3.80	6.50
Magnesia, ...	trace.	trace	0.30	0.30	0.30	7.10
Sulphuret of Iron,................		7.30				
Quartz Sand and Silica,............	5.6	2.30	58.4	73.4	78.9	71.1

* Analyzed by Holger, Liebig and Kopps, Annual Report on the Progress of Chemistry, &c. 1850, Vol. IV. p. 562.

TABLE 5.—Chemical Composition of the Limestones of Massachusetts, according to Prof. Hitchcock. Geology of Massachusetts, vol. 1, p. 80, 81.

100 PARTS CONTAIN.

LOCALITY.	Carbonate of Lime,	Carbonate of Magnesia,	Peroxide of Iron,	Silicia, Alumina, &c.	Specific Gravity,	Per Centage of Quick Lime,
North Adams, Crystalline White,	99.60		trace	0.40	2.74	55.78
Lanesboro, do do	99.40		trace	0.60	2.69	55.66
West Stockbride, do do	98 10	1.16	0-14	0.60	2.67	54.94
do do do do	98.67	0.47	0.08	0.78	2.81	55.25
Lanesboro, best for Marble,	96.11	2.28	0.22	1.39	2.74	53.82
Boston Corner, White Crystalline,	87.32	1.20	0.25	11.25	2.69	48.90
Hancock Greyish do	93.38	3.56	0.57	2.49	2.67	52.29
Worthington, White do	99.85		0.15			55.92
Bernardston, do do	98.38		0.62	1.00	2.72	55.09
Whately, Grey, do	66.00			34.00	2.72	36.97
do do do	64.66	5.01	1.54	28.79		36.21
Southampton, Grey do	38.40			61.60	2.93	21.50
Walpole, do do	70.30			29.70	2.80	39.27
Attleborough, do Compact,	94.60			5.40	2.71	52,98
Norwich, do Micaceous,	53.80			46.20	2.79	30.13
Sheffield, White Crystalline, Girard College Quary,	97.80			2.20	2.75	54.77
Egremont, White Crystalline,	92.80	1.20		6.00	2.69	51.97
Sheffield, Dolomitic Granular,	58.04	40.40		1.20	2.84	32.70
do do Marble,	54.87	40.61	0.38	4.14	2.83	30.73
Lanesboro, Grey Marble,	93.60	5.50	0.60	0.30	2.76	52.42
New Ashford, Flexible Marble,	81.80	16.20	0.60	1.40	2.68	45.81
New Marlborough Crystalline, Dolomitic,	54.24	44.28	0.59	0.89	2.81	30.37
do do do do	55.45	42.76	0.86	0.93	2.88	31.05
Tyringham, South part, Magnesian,	54.34	44.24	0.67	0.75	2.77	30.43
do Northwest part, do	61.88	32.56	0.46	4.10	2.82	34.65
Becket, Southeast part, do	58.31	28.61	1.24	11.84	2.84	32.65
Pittsfield, Grey, fine Granular,	**54.60**	**43.92**	**0.55**	**0.93**	**2.86**	**30.57**
Williamstown, Saddle Mt.,	**55.79**	**42.96**	**0.47**	**0,78**	**2.79**	**31.14**
do Grey, near the College,	**52.31**	**32.79**	**0.74**	**14.16**	**2.82**	**29.29**

TABLE 5.—Limestones of Massachusetts, continued.

LOCALITY.	Carbonate of Lime,...	Carbonate of Magnesia,..........	Peroxide of Iron,...	Silica, Alumina, &c.,	Specific Gravity,....	Per Cent of Quick Lime,.........
Great Barrington, Clouded Marble,.........	60.30	38.09	0.65	0.96	2.84	33.77
Compact Limestone, Agawam,.............	30.81	18.33	5.53	45.33		17.25
do do do...............	26.04	13.45	6.51	54.00		14.58
Argillaceous Limestone, Ashfield,..........	55.16	22.21	7.07	15.56		30.89
Micaceous, do Ashfield,.............	46.85	1.60	1.55	50.00		26.24
do do do................	45.13	3.50	2.70	48.64		25.37
Newbury,..............................	80.72	2.97	0.72	8.00		45.20
Lanesboro,............................	56.82	38.50	0.67	4.01	2.81	31.82
Lee,..................................	54.8	44.98	0.22		2.77	32.88
Dalton,...............................	56.58	43.07	0.35		2.86	31.68
Bolton Quarry, Crystalline,..............	61.80	27.00		1.20	2.80	34.61
Chelmsford Quarry, do..................	56.52	39.38	0.90	3.20	2.85	31.65
Stoneham, White Compact,..............	59.28	15.71	1.21	23.80	2.84	33.19
West Springfield, Grey Fetid,.............	93.48	0.90		5.60	2.73	52.35
Sprinfigeld, Chicopee Compact Septaria,.....	46.06	27.35	5.62	20.97	2.74	25.75
do do Fetid Grey,.............	86.80			13.20	2.73	48.61
do Cabotville, Septaria,..............	43.69	39.35	3.39	13.57		24.47
Middlefield, Coles Brook, White,...........	56.25	31.56	1.12	11.07	2.78	31.50
Middlefield, Coles Brook, White,...........	88.02	9.91	0.15	1.92	2.71	49.29
Blanford, White,.........................	51.66	39.49	0.91	7.95	2.77	28.93
Littleton, White Crystalline,..............	54.70	43.35	0.51	1.46	2.87	30.63
Sherburne, Bowlders, White,.............	60.43	29.84	2.36	7.37		33.84
Concord, S. W. part Grey,................	77.33	1.65	1.19	19.83		43.30
West Natick, Grey Crystalline,............	72.10	7.50		20.40	2.75	40.38
West Natick, Grey, finer specimen,.........	56.81	39.08	1.37	2.74		31.81
West Compact, Yellowish, Railroad Cut,....	54.20	0.60		45.20	2.68	30.35
West Compact,..........................	61.18	12.30	1.27	25.25		34.26
Claystone, Hadley,......................	56.60			43.80		31.71
do North Adams,...................	53.60	1.20		45.20	2.60	30.02
do West Sprigfifield,.................	48.40			51.60	2.68	27.10

TABLE 6.—Chemical Composition of the Marls of Massachusetts according to Professor Hitchcock.—Geology of Massachusetts, vol. 1, p. 70.

LOCALITY.	Phosphate of Lime......	Carbonate of Lime......	Carbonate of Magnesia..	Soluble Geine	Insoluble Geine.....	Silicates	Water of Absorption....	Specific Gravity.......	REMARKS.
Stockbridge..........................	0.7	73.4	0.15	4.3	4.6	13.5	3.3	1.82	2½ feet thick.
do. North-east of the Village......	0.6	46.0	tra.	5.0	8.9	36.6	2.9	....	
do. do. do.	0.8	31.8	....	0.6	3.8	59.8	1.7	....	Sulph. of Lime 1.5.
Pittsfield, east of the Village..............	0.7	86.4	0.46	3.1	3.0	3.01	3.0	1.82	4 feet thick.
do. s. w. do. do.	0.4	64.8	tra.	3.1	3.2	25.2	1.9	....	[water.
West Stockbridge.........................	0.5	74.8	0.53	1.7	5.0	14.7	2.8	1.61	Exposed to running
Lee Sedgwick & Co's Mills................	1.0	93.2	....	1.2	2.1	0.9	1.6	1.89	9 to 12 feet thick.
L. Bassets bed near surface..............	1.4	93.0	....	1.8	2.2	2.2	0.4	....	
do. do. 10 feet below surface......	1.0	88.8	....	1.6	2.8	4.4	1.4	1.75	
do. do.	1.2	86.9	....	2.6	3.4	5.0	1.6	....	
Sedgwick's Mills	1.0	83.6	....	0.8	4.4	9.2	1.0	....	
Farmington, Conn.........................	0.4	64.4	....	3.0	9.5	17.8	2.9	....	2.0 Sulph. of Lime.
Marly Clay, Williamston..................	....	11.7	1.86	....	....	75.77	2.3	....	
do. North Adams................	....	28.0	1.59	....	....	64.56	0.7	....	
do. South Lee....................	....	12.2	2.02	....	....	73.36	3.0	....	
do. Springfield..................	....	7.6	2.36	....	....	79.21	3.8	....	

TABLE 7.—Limestones of Rhode Island.*

LOCALITY.	VARIETY.	Carbonate of Lime......	Inso uble Matter......	Oxide of Iron	Magnesia	Lime.......	Specific Gravity.......
Cumberland Hill, F. Brown..........	White, Greenish. Granular........	52.2	6.	.....	40.6	29.4	2.728
do do......................	Green-Stone, (8.0 water)...........	68.8	23.2	1.al	6.2	38.7	.....
Johnston, Mr. Brown.................	Stone-white, yellowish spots and crystalline	55.2	46.6	.....	4.2	31.1	.....
do Mr. Je kins.................	White, compact, sub-crystalline....	56.1	11.4	.....	32.50	31.6	.....
North Providenee.....................	Stone-white and Green Crystalline.	97.2	0.8	.....	0.6	54.6	.....
Newport Harbor, Lime Islands........	Compact blue and Buff-colored....	53.2	7.0	1.9M	37.9	29.9	2.824
North Providence, Lime Quarry.......	Stone-white and compact...........	68.6	8.5	.....	21.	38.6	.....
Smithfield, Harris Rock...............	Rhomb. Spar.......................	92.8	.....	.....	3.4	52.2	.....
Shore, near Fort Adams..............	Yellow buff colored, compact......	50.9	4.3	2.1M	2.27	28.7	.....
Smithfield, Harris Quarries...........	Soft Rock..........................	92.4	6.	0.4M	1.2	52.	.....
do Harris Rock.................	First Quality Hard Rock..........	60.4	1.	2.6	3.6	34.	.....
do Dexter's Quarry...........	White, granular and crumbly.....	94.8	1.6	.....	.....	53.4	2.663
do do do	Compact, white, insoluble matter, in acicular crystals.............	64.6	2.	T.	32.	36.4	2.850
do S. Arnold.................	Stone-white, coated, with talc and crystalline......................	50.6	3.8	T.	44.4	28.5	.....
do Harris Quarry..............	1st quality soft blue-stone, with blue and white stripes, ditto.......	92.2	1.0	.....	6.8	51.9	.....
do Harris Rock................	Crystalline and granular...........	95.8	1.4	.....	2.8	53.	2.681
do do do	Very clear light blue stratified and crystalline.......................	87.	12.3	.....	.....	49.	2.715
do E. Angell..................	Stone-White and crystalline........	97.6	1.	.....	.....	54.9	.....

*Geological and Agricultural Survey of Rhode Island, by Charles T. Jackson, M.D., p. 246.

TABLE 8.—Limestones and Marls of Maryland. *

100 PARTS CONTAIN.

NAMES AND LOCALITIES.	Carbonate of Lime,..	Lime, ...	Carbonic Acid, ...	Magnesia, ...	Oxide of Iron and Soluble Silica,.....	Insoluble Silica,...	Potash, ...	Phosphate of Lime,
Limestone, Pipe Creek, Carrol co.		53.40	43.17	1.13	1.90	0.40		
Limestone Long Green, Baltimore co., ...		36.73	35.97	6.25	3.30	17.75		
Limestone, Howard county,....		35.27	29.41	1.76	8.39	25.17		
Marl, ...	26.5			2.70		66.5	1.30	
Marl, near Fort Tobacco,.......	12.91				9.45	55.73	2.07	
Coral Marl, Talbot county,......	26.91				3.07	67.54		2.90
Coral Marl,..................	26.13				11.62	55.58		6.67
Fresh Water Marl, ...		52.53	41.29			6.16		trace

* First Report of Philip T. Tyson, State Agricultural Chemist to the House of Delegates of Maryland. 1860, p. 71, 81.

TABLE 9.—Chemical Composition of the Limestones and Marls of South Carolina.*

100 PARTS CONTAIN.

NAMES AND LOCALITIES.	Carbonate of Lime, ..	Carbonate of Magnesia	Silica........	Alumina of Iron......	Phosphate of Lime, Magnesia and Iron,	Organic Matter,......
Limestone, from Limestone Springs........	90.56		6.40	3.14		
Crystalline Limestone, Saluda, Laurens Dist.	92.00	1.00	7.00			
Limestone, Garlington's Quarry,..............	86.00	0.50	13.50			
do York..............................	85.00	0 50	10.00	4.50		
do do Harden's Bed, ...	86.00	0.50	11.00	2.50		
do do................................	75 00	trace.	16.00	9.00		
do Brasstown Creek, Pickens Dist...	70.00		25 00	5.00		
Marl from Tilly's Lake. Waccamaw.........	65.00		20.00	15.00		
do do. Black River, Sumpter,.............	70.00		20.00	9.50	0.5	
do do do do do	67.00		16.50	16.50	trace.	
do do 6 miles S.E. of Darlington C. H...	60.00		35-00	15.00		
do do do do do do do..	68.00		22,00	9.600	0.4	
do do do do do do do..	64.50		20.00	15.00	0.5	
do do Dr. Holmes' Marl Pit, Cooper River	87.50		6.00	5.00	1.50	
do do Pooshee..........................	90.00		4.00	5.50	0 50	
do do Bees' Ferry, on the Ashley River,.	55 00		32.00	9.00	4.00	
do do Combahee River....................	36.00		39.50	25.50		2.00
do do Thomas Parish, near the Coast...	60.00		36.00	4.00		
do do Wadmalaw,.........................	57.00		40.00	3.00		
Marly Limestone from Wilmington, N. C......	80.00			1.00	2.80	
Argillaceous Chalk Marl. Mr. Dixons' Plan'n	63.50	7.00	16.00	4.75	2.00	
Greyish White Chalk Marl, Drayton Hall, ..	66.04	2.56	10.20	1 00	8.60	
do do do do Goose Creek, b. C.R.	68.00	1.20	16.80	0.40	9.20	
do do do do Elwood, Cooper R..	76.88	1.40	16.20	trace	2.60	
do do do do do do do	72.06		15.00	0.46	6.80	
Yellowish Grey Chalk Marl, (Green Marl) Ashley River, 14 miles of Charleston,.....	58.00		28.00	0.80	8.80	
Yellowish Grey Chalk Marl, Church Creek..	44.40	9.58	29.08	0.80	7.00	
do do do Pen Pen on the Ashepoo,	58.56	2.12	34.41	0.40	2.47	
do do do do do	57.55		30.43	0.66	6.09	

*As determined by Protessor Shepard, Dr. Smith, and Prof. M· Toumey. *Geology of South Carolina, by M. Toumey.*

TABLE 10.—Per centage of Carbonate of Lime in the Shell, Limestone and Marls of South Carolina.*

NAMES AND LOCAILTIES.	PER CENT OF CAR-BONATE OF LIME.	NAMES AND LOCALITIES.	PER CENT OF CAR-BONATE OF LIME.
CRETACEOUS MARL.		Sav. River, above Three Runs,	90
Peedee River,		Lower Three Runs,	50½
Birch Ferry, Peedee River Bottom,	36	do do do	32
do do do do 3 feet from Bottom,	33	ASHLEY RIVER AND TRIBUTARIES.	
do do do do 10 feet from Bottom,	51	Brisbane's Landing,	64
do do do do 12 feet from Bottom,	66	do do	74
Mouth of Jeffrey's Creek, Surface,	24	do do	6
do do Willow Creek, do	45	O'Neal's Landing,	76
do do do do Marlstone,	77	Drayton Hall,	63
Binghams, on Stage road,	82	Bee's Ferry,	50
Leggetts upper part,	57	Magnolia,	75
Giles Bluff,	42	Greer's Landing,	52
do do next to low water,	14	Pringles,	75
do do Marlstone,	86	Cattell's Bluff,	52
Meyers Land,	84	do do	78
do do	76	Cohen's Land,	62
Gibson's Bluff,	82	J. A. Ramsay's Land,	67
do do	10	Cedar Grove,	76
Brown's Upper Ferry,	72	Oak Forest,	36
Stony run, Georgetown,	55	Wassamasaw Swamp,	72
MARLS ON LYNCH CREEK.		Indian Fields,	47
Sparrow Swamp, at top,	18¾	do do	50
do do 3 feet deep,	21	ARTESIAN WELL, CHARLESTON.	
do do 6 do do	25½	120 feet below the surface,	65
do do Marlstone,	66	135 do do do do	56
Henry Hams, Sparrow Swamp, 5 ft	25	160 do do do do	69
Lynch Creek, top,	15	162 do do do do	44
do do 6 feet deep,	27½	180 do do do do	59
do do 3 feet deep,	27½	200 do do do do	54½
EOCENE AND MORE RECENT MARLS.		225 do do do do	60½
MARL AND MARLSTONE OF SAVANNAH RIVER AND TRIBUTARIES.		227 do do do do	58½
Shell Bluff, white compact marl,	89	230 do do do do	55
do do darker,	52½	258 do do do do	58
do do Harder,	86	270 do do do do	66
do do Stony Marl,	94	274 do do do do	79
do do Concrete Shells,	82	282 do do do do	79
do do	60	309 do do do do	74
do do Cream Colored Marl,	86	COOPER RIVER.	
Lower Three Runs,	74	Grove, Dr. Ravenel's,	52
do do do	62	Mulberry, Dr. Millekin's'	60
do do do	64	do do	76
do do do	62	do do	42
do do do	22	Lewisfield Simon's,	84
Gillett's Mills,	64	Point Comfort, R. W. Ropers,	79
do do	46	Steep Bluff,	80
Sav. River, above Three Runs,	92	Rectory,	80
		Monk's Corner Road,	80
		Near Santee Canal,	95
		Isaac Porchers,	81
		do do	61
		Near Santee Canal,	90

*NOTE.—Determined by Mr. Ruffin, of Virginia. Report of the Agricultural Survey of South Carolina, by Edmund Ruffin. See also Geology of South Carolina, by M. Tuomey.

TABLE 10—Continued.

NAMES AND LOCALITIES.	PER CENT OF CARBONATE OF LIME.	NAMES AND LOCALITIES.	PER CENT OF CARBONATE OF LIME.
SANTEE RIVER.		Huspa Creek,....................	16
Balls Dam,........................	91	do do	93
Old Jamestown Landing,.........	66	PLIOCENE MARLS.	
Lenuds Ferry,.....................	93	Giles Bluff, Peedee,..............	78
do do..............................	97	do do do do..........................	60
Williamsburgh,.....................	91½	do do do do..........................	64
Eutaw,..............................	94	do do do do..........................	66
do..................................	88	Godfrey's Ferry,.................	69
Rocks Creek,......................	94	do do..............................	89
Nelsons Ferry,....................	83	Gibson's Landing,................	81
Vance's Ferry,.....................	86	do do	74
do do................................	90	Witherspoon Bluff,...............	62
Hale's Mill,........................	84½	do do..............................	74
do do	51	Goose Creek, near Cooper River,.	82
Stout's Creek,.....................	20	do do do do do...	80
Edisto River,.....................		Swift Creek, near Darlington C. H.	64
Binnaker's Bridge, ...	36	do do do do do	69
Johnson's Bridge,................	38	do do do do do	63
do do...............................	36	do do do do do	64
Walker's Bridge,..................	31	POST-PLIOCENE, OR COAST	
do do...............................	87	MARL.	
Cawcaw Swamp,.................	62	Doctor's Swamp, Johnson Island,.	41
do do...............................	26	Stone Creek, Edisto Isld,.........	18
LITTLE SALKEHATCHIE.		do do do do	27
Dowling's Mill,...................	7	Edisto Island,.....................	58
Cedar Spring,.....................	73	Distant Island,...................	47
Ashepoo River,..................	92		

Chemical Analysis of Shell-Marl, Green county, Arkansas, according to Dr. David Dale Owen.*

Water,	1.3	The insoluble Sicates consisted of—	
Insoluble Silicates,	8.49		
Carbonic Acid,	2.7	Silica,	72.8
Peroxide of Iron,	3.6	Alumina, tinged with Iron,	6.8
Alumina,	2.0	Lime,	0.8
Lime,	2.9	Magnesia,	0.3
Magnesia,	1.2	Potash,	0.9
Phosphoric Acid,	0.45	Soda,	3.2
Potash,	0.05	Manganese,	trace
Loss,	0.45		
	100.00		84.8

* First Report of a Geological Reconnoissance of the Northern counties of Arkansas, 1857–'58, by David Dale Owen. Little Rock, 1858, p. 27.

Chemical Analysis of Shell Marl, Hickman county, Kentucky. *

Water, - -	1.35	The insoluble Silicates consisted of—	
Organic Matter, soluble in Water, - -	0.30	Silica, - - - -	60.6
Insoluble Silicates, -	73.30	Alumina, - -	7.4
Carbonic Acid, -	10.00	Lime, - - -	1.1
Lime, - -	6.80	Loss, Alkalies and a trace of Oxide of Iron, not estimated, - - -	3.8
Magnesia, - -	3.78		73.3
Alumina and Peroxide of Iron, - -	2.80		
Chlorine, - -	0.12		
Loss, Alkalies and Phosphoric Acid not determined, - - -	1.55		
	100.00		

* By Dr. David Dale Owen. Loc. Cit. p. 27.

TABLE 11.—Chemical Constitution of the Limestones and Marls of Alabama, according to Profs. Toumey and Mallet.*

LOCALITY AND NAMES.	Carbonate of Lime,....	Carbonate of Magnesia,	Silicates,..........	Alumina,..........	Oxide of Iron,........	Phosphoric Acid,......	Silica, Soluble in Acid,	Potassa,..........	Phosphate of Lime,...	Specific Gravity,......
METAMORPHIC AND SILURIAN LIMESTONE.										
Talladega County Marble,..	99.47	0.38	trace							2.712
Marble, Talladega County,.	35.67	2.51	61.15	0.39						2.761
Grey Compact Marble, Talladega County,........	96.22	0.66	2.79	trace	0.20					2.711
Greyish Limestone, Big Sandy Creek,................	96.37	1.72	1.04	trace	0.25					3.717
Dark Grey, Crystaline Limestone, Talladega County,.	90.43	4.28	4.30	trace	0.74	trace				2.698
Dark Compact Limestone, Shelby County, ...	90.52	4.93	4.35	trace	0.49					2.717
White Crystaline Limestone, Talladega County,........	55.48	44.04	0.09	trace	0.31					2.846
White Marble, Macon Co.,..	55.07	43.95	0.40	trace	0.19					2.885
Crystaline Limestone, do do	54.57	42.94	1.39	trace	0.26					2.865
White Crystalline Limestone Macon County,..........	59.33	37.93	5.05	trace	2.24					2.833
Compact Greyish Limestone Macon County, ...	59.33	38.39	1.81	trace	0.33					2.860
Greyish Limestone, do do..	56 07	41.84	1.64	trace	1.04					2.845
Blu-Grey Limestone, do do	55.16	44.32	0.79	trace	0.44					2.844
Brownish White Limestone, Jone's Valley,...........	54.62	40.13	4.64	trace	0.80					2.617
Yellowish Grey, Crystalline Limestone, Chockolocho,.	55.17	43.39	0.45	trace	0.89					2.853
Dark Bluish Grey, Oxford,	51.48	34.32	10.55	0.47	3.05					2.847
CARBONIFEROUS LIMESTONES.										
Greyish Brown Limestone, Huntsville,................	64.03	1.76	31.91	trace	2.03	trace				2.676
Bluish Grey Granular Limestone, Tennessee River,...	92.17	0.61	5.57	0.32	0.79	trace				2.702
Cream Colored Limestone, Franklin Co., near Athens,	99.21	0.39	0.39	trace	trace					2.592
Limestone with Encrinites, Maple Creek,............	54.25	0.34	43.44	0.24	1.21	trace				2.641
Stone containing Bones of Fossil Fish, Cowpens Creek, ...	16.41	trace	68.28	trace	0.36	6.31	0.44		1419	
CRETACEOUS LIMESTONES.										
Shell Conglom'rate, Macon co	53.66	0.97	44.60	0.27	0.22					
Fossiliferous Limestone, Macon County,...........	88.82	2.18	7.20		0.94	0.24				
Fossiliferous Limestone, Macon County,..........	46.96	1.19	50.61	trace	0.78	0.26				2.649
Dark Grey Limestone, Macon County,............	51.92	0.61	45.71	trace	1.60			trace		2.611
Rotten or Prairie Limestone, Demopolis,..............	75.07	0.72	21.16	0.79	1.44	0.20	0.14	0.094	0.40	1.976
Rotten Limestone, Cahawba,	64.37	0.79	30.44	0.75	2.19	0.25	0.59	5.041	0.54	1.923
Rotten Limestone, Green County, ...	80.48	0.53	13.09	0.98	1.24	0.17	0.19	0.113	0.30	2.064

*Second Biennial Report on the Geology of Alabama, by M. Toumey, A. M. Edited by Prof. Mallet.

Table 11.—Chemical Constitution of the Limestones and Marls of Alabama, continued.

LOCALITIES AND NAMES	Carbonate of Lime,	Carbonate of Magnesia,	Phosphoric Acid,	Peroxide of Iron,	Alumina,	Chlorine,	Silica,	Potassa,	Silicates,	Specific Gravity,
TERTIARY LIMESTONE AND MARLS.										
Brownish Yellow Limestone, Clarke County,	98.84	0.96		1.81	0.31	trce			1.67	2.569
Cream Colored, Limestone or Marl, Clarke County,	94.85	1.57	0.31	0.27	trce	"			2.44	2.151
Shell Conglomerate, Clarke County,	93.19	1.09		1.03	0.26	"		trace	4.15	
Alabama Green Sand, Coal Bluff, Alabama River,	0.91	1.35		20.93	6.70		57.82	4.81		2.297
Alabama Green Sand, Coal Bluff, Alabama River.	1.18	2.05		19.34	6.42		57.28	4.95		2.297
Alabama Green Sand, Coal Bluff, Alabama River,	1.04	1.70		20.13	6.56		57.56	4.88		
Alabama Green Sand, Coal Bluff, Alabama River,	0.71	0.87		19.24	5.48		58.91	4.48		
Alabama Green Sand, Coal Bluff, Alabama River,	0.92	1.48		21.06	4.71		58.74	3.26		2.349
Alabama Green Sand Marl, Coal Bluff,	29.33		1.003					1.673		
New Jersey Green Sand,	0.43	0.27		23.72	5.76		50.99	10.07		
Concretionary Mass of Fossil Shells, Railroad Cut, near Columbus, Ga.,	70.84	trace	0.103	0.04	1.94		0.21		26.26	
Bluish Green Marl, Troy, Pike County,	21.42	0.16	trace	2.88	0.15	"			75.08	
Marl, Bluish Green, Chattahoochee River,	25.87	0.31	trace	3.23	0.94	"			68.71	
Marl, Bluish Green, Below Eufaula,	13.47	1.01	0.176	3.21	1.08		0.54		79.14	
Yellowish Brown Marl, Camden,	23.18	trace	0.057	3.35	0.32		0.30		72.06	

TABLE 12.—Composition of Green Sand from the United States and of the Green Earth of Europe.

	Martha's Vineyard, according to Dr. L. S. Dana,	New Jersey, according to Prof. Rogers,	Germany, according to Berthen,	Scotland, according to Thomson,	Alabama, according to Prof. Mallet,	Alabama, according to Prof. Mallet,	Alabama, according to Prof. Mallet,	Alabama, according to Prof. Mallet,
Silica,	56.700	48 45	46.1	48.16	57.83	57.28	57.56	58.91
Alumina,	13.320	6.30	5.5	16.85	6.70	6.42	6.56	5 48
Protoxide of Iron,	20.100	24.31	19.6	19 00	30.93	19.34	20.13	19.24
Potash,		12.01	5 3	6.56	4.81	4.95	4.88	4.58
Magnesia,	1.176		3.8	2.91	1 35	2.05	1.70	0.87
Lime,	1.624	trace		2.67	0.91	1.18	1.04	0.71
Water,	7.000	8.40	8.9	2.35	8.17	8.17	8.17	8.17
Quartz,			11.5					

The Green earth of Europe appears to have resulted from the decomposition of Trap, as it is found occupying cavities in trap rocks; and it is highly probable that the Green Sands of America have resulted from the decomposition of the Trap dykes found along the Atlantic slope, from New Jersey to Alabama. This being the origin of the Green Sand and Green Earth, we have every reason to believe that it will be found in Georgia. If it should be found in large quantities it will prove an invaluable fertilizer to the Planters of Georgia, on account of the large proportion of Potash which it contains. We shall show hereafter that Potash enters largely into the composition of Cotton, Corn, and in fact, of all plants and animals.

The careful comparison of the results, of the chemical examination of 394 specimens of Limestones and Marls, from various parts of Europe and America recorded in the preceeding tables establishes the following conclusions.

1. The Shell Limestone of Georgia, is richer in Lime and contains less impurities than the majority of the Limestones and Marls of Europe and of the United States and is fully equal to the best Limestones aud Marls found in Europe and America.

2. The Shell Limestone of Georgia is capable of furnishing lime for architectural purposes, equal in purity and in quality to any in Europe or in America.

3. The Shell Limestone of Georgia is more suitable for agricultural purposes than the Limestones of the older formations in Europe and in America, in two most important respects.

(a) It contains less Magnesia.

(b) It contains a much larger proportion of the phosphates.

In the Limestones of the older formations, Phosphoric Acid, and its compounds are either absent or exist in such minute portions, that when employed in agriculture the effects produced by the phosphates must be unimportant. In the Shell Limestone of Georgia on the other hand, the Phosphates exist in from $\frac{1}{3}$ to 2 per cent. and will exert decided beneficial effects upon vegetation. If we calculate the quantity of Phosphate of Lime, contained in the number of bushels of Shell Limestone which should be applied to each acre of land, we will find that it will amount to several hundred pounds; and in fact to a greater quanty than that which we are accustomed to add to each acre of land, in the form of most expensive, "super Phosphates" and Phosphatic Guanos, whose value depend almost entirely upon the Phosphates which they contain.

The establishment of this result is of the highest value to the State of Georgia; for we have thus demonstrated, that Georgia possesses inexhaustible stores of the Phosphates which are considered by agriculturists to be amongst the most valuable fertilizers.

4. The Marls of Georgia are as rich in Carbonate of Lime as the Marls of Europe, and of other portions of the United States.

5. The Marls of Georgia are richer in Phosphoric Acid and its compounds, than the majority of the Marls of Europe and of other parts of the United States, and are fully equal to the richest Marls of Maryland, South Carolina and Alabama.

One of the beds of Georgia Marl yielded near seven per cent. of Phosphate of Lime, and would give to the 300 bushels more than one thousand pounds of Phosphate of Lime. Several of the analyses of the Marls of Maryland and South Carolina, show a higher per cent. of Phosphate of Lime, than those of Georgia; but I find upon reference to the accompanying description, that the specimens were selected from deposits rich in bones, and excrements of fish, and fragments of Corals. I have in my possession bones and Coprolites from the Shell-Limestone and Marl-beds of Georgia which would yield a higher percentage of Phosphates, even than those of Maryland and South Carolina; but they have been excluded from my present tables, that the analyses now presented, might faithfully present the average composition of the Eocene Lime fomation of Georgia.

In the Marls, then, as well as in the Shell Limestone, Georgia possesses, inexhaustible stores of Phosphate of Lime.

We may, then with truth affirm that in this important element of fertility Georgia is independent of the world.

6. The Marls from different localities vary in Chemical constitution within wide limits, some deposits are rich in Carbonate of Lime, others in Phosphate of Lime, and others again in Organic matters.

This diversity is highly important in an agricultural and commercial point of view.

It is a fact well established, that the application of Marls to the soil, should be guided by the constitution of the Marl and of the soil. This diversity in the Chemical constitution of the Marls and Shell Limestone of Georgia allowes of latitude in the choice of fertilizing agents for the different varieties of land.

This diversity in Chemical constitution of the Marls and Shell-Limestone of different localities, demonstrates the importance of careful Chemical Analyses of all the varieties of Marl and shell limestone in Georgia.

The great importance and value to the State, of a careful and extended chemical examination of the Marls and Shell Limestone of Georgia will be still farther illustrated by the valuable results obtained in Europe by similar examinations.

In the lower Chalk beds of Sussex and some of the Southern counties of England, extensive layers of a yellowish brown earth have been discovered to be exceedingly rich in Phosphoric Acid.

According to the careful Analysis of Th. J. Herapath,* it possessed in the 100 parts the following constituents:

Carbonate of Lime		28.400
Carbonate of Magnesia		traces.
Sulphate of Lime		0.736
Tribasic Phosphate of Lime, 21.880.	Phosphoric Acid	10.098
	Lime	11.790
Phosphate of Magnesia		traces
Phosphate of Sesquioxide of Iron, 24.760.	Phosphoric Acid	11.728
	Iron	13.032
Phosphate of Manganese		traces.
Phosphate of Alumina, 6.998.	Phosphoric Acid	4.789
	Alumina	2.209
Fluoride of Calcium		traces.
Organic Matters		traces.
Silica, with some silicate of Alumina and Silicate of Iron.		13.240
Chloride of Sodium		traces.
Sulphate of Soda,		traces.
Water		3.400
Loss		0.586

In every hundred parts of this earth there are found 26,615 parts of Phosphoric Acid.

The Coprolites from various parts of England, have also been proved by Chemical Analysis to be rich in Phosphoric Acid, and, when obtained in sufficient quantities, have proved most valuable fertilizers.

*Chem. Gaz. 1849.70 Liebig and Kopps Annual Report on Chemistry, Vol. 3. 1849, p. 584.

The following Analysis of Coprolites by Herapath will illustrate their geneıal constitution.

TABLE 13.—100 PARTS CONTAINED.

	Coprolite from the coast of Suffolk, weighing 700 grs. sp. gr 2.815.....	Coprolite from the coast of Suffolk..........	Coprolite from the lias bed of Lyme Reg, weight 9 oz
Carbonate of Lime........................	12.280	39.50	23.70
Phosphate of Lime....	7.09	15.86	60.80
Phosphate of Magnesia.....................	traces	.....	.....
Phosphate of Alumina.......................	6.90	4.71	.....
Phosphate of Sesquioxide of Iron.............	1 60	9.20	4.10
Carbonate of Magnesia.....................	traces.	0.50	.....
Sulphate of Lime........................	traces.	....	1.8
Fluoride of Calcium......................	0.608	1.700	.....
Silicic Acid............................	5.792	10.600	1.6
Water and Organic Matters................	0.400	11.600	6.10
Alumina................................	......	6.200	....

In England various Marls, petrifactions and bodies resembling Coprolites, and Phosphoric Acid concretions have been discovered in the chalk formation to be rich in Phosphoric acid, and are extensively employed as manure.

The results of the careful examinations of these strata by J. M. Paine and J. T. Way, demonstrate that the Phosphates are differently distributed through the Strata composing the same formation, and that the proportion of Phosphoric Acid and of the combinations of Phosphoric Acid do not correspond in any definite manner with the proportions of Carbonate of Lime.

Thus, careful experiments upon these strata in the Chalk formation, show that the soft white chalk with flint, forming the upper division of the formation contains 96.06 per cent. of carbonate of Lime, and only 0.26 per cent of phosphate of Lime; the second division, the hard white Chalk without flint, contains no Phosphoric Acid; the third division the Chalky Marl, contains 66.69 per cent. of Carbonate

of Lime, and 1.82 per cent of Phosphoric Acid, being much poorer in Carbonate of Lime, and much richer in Phosphoric Acid, than the upper division; while the upper Green Sand is far richer than the other divisions in Phosphoric Acid, yielding in some parts especially in its upper thin layer of Marl (in depth from a few inches to 10 to 15 feet) which contains numberless fossils, as much as 33 per cent. of Phosphoric Acid.

The soil surrounding these formations rich in Phosphoric Acid, does not contain an unusual amount of Phosphoric Acid except when the fossils, and the formations have been mixed with the soil, or when the soil has resulted from the disintegration of the former.

The following results of the experiments of J. M. Paine and J. T. Way* will illustrate these important facts:

*Liebig and Kopps Report on Chemistry &c Vol. 3 p. 584-585.

TABLE 14—Chemical Composition of some of the divisions of the Chalk formation of England; showing the distribution of Phosphoric Acid and the Phosphates and fossils.

NAME, STRATA AND CHARACTER OF CHALK AND MARL.	Phosphoric Acid	Lime	Carbonic Acid	Magnesia	Aumina and Oxide of Iron	Potassa	Soda	Insoluble Silica	Soluble Silicic Acid	Sulphuric Acid	Water Organic mat. and Hydrofluoric Acid	Total
Chalky Marl, 3d division	1.82	37.71	28.98	0.68	3.04			19.64	6.45			98.32
Upper Green Sand, upper layer of Marl. A branched Alcyonite. There is also in it a large amount of Amorphous Spongiform bodies, from 8 to 10 pounds weight, containing from 5 to 50 per cent of Phosphate of Lime, the amount of which, increases however from without inwards	29.87	42.29	8.77		6.87			7.68	3.28		4,52	100.0
Upper Green Sand, upper layer of Marl soft. shapeless body containing fossils	27.13	39.85	8.77	0.96	10.60			7.18			2.49	100.26
Green Sand, upper layer of Marl, sifted from the fossils	9.61	9.53	2.61	1.97	11.46			32.81			3.02	
Upper Green Sand, hardened Marl and little fossils which re-											2.64	99.94
main on the Sieve	9.31	15.24	2.35	1.43	13.11	3.10		26.83	29.14			97.21
Upper Green Sand, Marl from Bentley with the fossils	6.89	9.11	4.52	1.64	13.55			39.59	26.30		4.12	97.84
Green Sand. The fossils from the Marl from Bentley	33.03	46.50	5.58	trace	1.96			7.12	18.42		3.04	100.50
The Gault, the Second Division of the Green Sand	24.28	47.46	12.43	0.21	2.91			0.91	3.27		11.80	100.00
Lower Green Sand after pounding and removal of the principal											2.30	99.94
petrifactions	0.64	2.01	5.64	0.18	5.58			75.46	8.12			
Lower Green Sand. The petrifactions	20.80	23-86	1.06	0.37	3.35			43.87	3.25		3.44	100.00
Lower Green Sand Green Grains	20.65	34.61	4.01		8.22	1.79	1.87	18.53		5.13	2.28	97.09

We have every reason to believe that an extended and careful examination of the Calcareous deposits of Georgia, will lead to similar results.

Whilst the Marls and Shell Limestone thus far discovered during this agricultural survey of the State of Georgia, are amply sufficient for all the agricultural wants of Georgia, and if properly developed and used will not only reclaim her worn-out lands, but preserve them in their primitive fertility for untold generations, still the discovery of beds rich in the Phosphates would be of great value to the State, for at the same rates of transportaion, a much more valuable article would be obtained, and an active commerce in these native fertilizers might be established.

CHAPTER V.

COMPARISON

OF THE

SHELL LIMESTONE AND MARLS OF GEORGIA,

With various Commercial Manures.

CHAPTER V.

Comparison of the Shell Limestone and Marls of Georgia, with various Commercial Manures.

It is of the greatest importance, that the relative value of the native resources of Georgia should be carefully determined by an impartial comparison with the most reliable Fertilizers offered in the American market; for the value of the native products should control the price of the manufactured and imported manures. Whilst we would not intentionally injure any honest manufacturer or vender of Fertilizers, we would on the other hand, do all in our power to develope the resources of our native State, and use every fair means to protect the Planters of Georgia in the purchase of Fertilizers, and prevent the ruinous drain of money which flows out of the State, without any other return than worthless compounds, foisted into public notice by false and brazen advertisements.

We will commence the comparison with those Fertilizers, which I have examined since my appointment as Chemist to the Cotton Planter's Convention, of Georgia.

1.—Rhodes Super-Phosphate of Lime.—This article is manufactured in Baltimore, Md. It is but just that I should state to the Convention that both the manufacturers and venders of this Fertilizer, have thrown open everything to my examination, and have manifested a determination to conduct all their operations in an open and strictly honest manner.

Samples of Rhodes Super-Phosphate, selected by myself on the 14th of April, from the entire stock of Messrs. J. A. Ansley & Co., Commission Merchants, Augusta, Ga., yielded the following average results.

ANALYSIS 14. RHODES' SUPER-PHOSPHATE FROM AUGUSTA.

			00 parts contain....	'00 pounds contain pounds	ɹ00 pounds contain pounds	300 pounds contain pounds	l00 pounds contain pounds	',000 pounds contain pounds..........	1 Ton of 2,000 pounds contain pounds ....
Free Trihydrated Phosphoric Acid 1.98	Phosphoric Acid,		1 44	1.44	2 88	4.32	5.76	14.40	28.80
	Water,		0.54	0.54	1.08	1.62	2.16	5.40	10.80
Soluble Phosphate of Lime, 14.76	Metaphosphate of Lime, 12.50	Phosphoric Acid,	8.78	8.78	17.56	26.34	35.12	87 80	175.60
		Lime,	3.74	3.75	7 50	8.25	15.00	37.40	74 80
	Water 2.26	Water,	2.26	2.26	4.52	6 78	9.04	22 60	45.20
Insoluble Basic Phosphate of Lime 16.50	Phosphoric Acid,		7.59	7.59	15.18	22.77	30.36	75.90	151 80
	Lime,		8.91	8.91	17.62	26.73	35.64	89.10	178 20
Bihydrated Sulphate of Lime Gypsum, 42,24	Sulphuric Acid,		19.64	19.64	39 28	58.92	79.56	196.40	392.80
	Lime,		13.76	13.76	27 52	41.28	55.04	137.60	275.20
	Water,		8·84	8.84	17.68	36.52	35.36	88.40	176 80
Carbon,			2 25	2.25	4.50	5.75	9 00	22.50	45.00
Silicates and Silicic Acid,			1.25	1.25	2 50	3.75	5 00	12.50	25.00
Water as Moisture,			16.84	16.84	33.68	50.52	67.36	168 40	336.80
Sulphate of Magnesia, Soda, Iron and Loss,			4.28	4.28	8.56	12.84	17.12	42.80	85.60
The principal Fertilizing agents were									
Free Trihydrated Phosphoric Acid,			1.98	1.98	3.96	5.94	7.92	19.80	39.60
Soluble Phosphate of Lime,			14.76	14 76	29.52	44.28	59.04	147.60	295.20
Insoluble Basic Phosphate of Lime,			16.50	16.50	33.00	49.50	66.00	165 00	330.00
Bihydrated Sulphate of Lime,			42.24	42.24	84.48	126.72	168.96	322.40	844.80

Samples from the stock of Messrs. Patten & Miller, Commission Merchants, Savannah, Ga., selected by my brother Charles Colcock Jones, Jr., Esq., of Savannah, yielded the following results:

ANALYSIS 15. RHODES' SUPER-PHOSPHATE, FROM SAVANNAH. 1ST SAMPLE.

	100 parts contain....	100 pounds contain pounds	200 pounds contain pounds	300 pounds coontain pounds	400 pounds contain pounds	1,000 pounds contain pounds	1 Ton of 2,000 pounds contain pounds ....
Free Trihydrated Phosphoric Acid 2.68 — Phosphoric Acid,..................	1.95	1.95	3.90	5.85	7.80	19.50	39.00
— Water,..............................	0 73	0.73	1.46	2.19	2.92	7.30	14.60
Soluble Phosphate of Lime 16.47 — Metaphosphate of Lime 13.92 — Phosphoric Acid,	9.73	9.73	19.46	29.19	38.92	97.30	194.60
— Lime	4.22	4.22	8 44	12.66	16.88	42.20	84.40
— Water, 2.52 — Water, ...	2.52	2.52	5.04	5 56	10.08	25.20	50.40
Insoluble Phosphate of Lime 16.75 — Phosphoric Acid,..................	7.79	7.69	15.38	23.07	30.76	76.90	153.90
— Lime,..............................	9.06	9.06	18.12	27.18	36.24	90.60	181.20
Bihydrated Sulphate of Lime (Gypsum) 44.36 — Sulphuric Acid,..................	20.64	20.64	41.28	61.92	82.56	206.40	412 80
— Lime,..............................	14.41	14.41	28.82	43.23	57.64	144.10	288.20
— Water,..............................	9.29	9.29	18.58	27.87	37.16	92.90	185.80
Carbon,......................................	2.05	2 05	4.10	6 15	8.20	20.50	41.10
Silicic Acid and Silicates,..................	0.80	0.80	0.60	2.40	3.20	8.00	16 00
Sulphate of Magnesia and Soda, Salts of Iron and loss,..............	2.09	2.09	4.18	6.27	8.36	20.90	41.80
Water as Moisture,..........................	14.80	14.80	29.60	44.40	59.20	148.00	296.60

The principal Fertilizing agents existed in the following quantities:

Free Trihydrated Phosphoric Acid,..................	2.68	2.68	5.36	8.04	10.72	26 80	53.60
Soluble Phosphate of Lime,..........................	16.47	16.47	32.94	49.31	65.88	164.70	329.40
Insoluble Phosphate of Lime,........................	16.75	16.75	33.50	50.25	67.00	167.60	335.00
Bihydrated Sulphate of Lime, (Gypsum)................	44.36	44.36	88.72	132.98	177.44	443.60	887.20

ANALYSIS 16. RHODES' SUPERPHOSPHATE OF LIME FROM SAVANNAH—2D SAMPLE.

			100 parts contain....	100 pounds contain pounds,........	200 pounds contain pounds	300 pounds contain pounds,........	400 pounds contain pounds,........	1000 pounds contain pounds,........	1 Ton of 2,000 pounds contain pounds, ..
Free Trihydrated Phosphoric Acid, 1.37	Phosphoric Acid,........		1.00	1.00	2.00	3.00	4.00	10.00	20.00
	Water,........		0 37	0 37	0.74	1.11	1 48	3 70	7.40
Soluble Phosphate of Lime, 15.56	Metaphosphate of Lime, 13.20..	Phosphoric Acid,......	9.50	9.50	19.00	28 50	38.00	95.00	190 00
		Lime,........	3.70	3 70	7.40	11.10	14.80	37.00	74.00
	Water, 2 36	Water,........	2.36	2 36	4.72	7.08	9.44	23 60	47 20
Insoluble Phosphate of Lime, (Bone Earth) 18.20......	Phosphoric Acid,........		8.37	8.37	16.74	25 11	33.48	83.70	167.40
	Lime,........		9.83	9.83	19.66	29.49	39.32	98.30	196.60
Bihydrated Sulphate of Lime, Gypsum, 44.26........	Sulphuric Acid........		20.59	20.59	41.18	61.77	82 36	205 90	411.80
	Lime........		14.41	14.41	28 82	43 23	57.64	144.10	288.20
	Water........		9.26	9.26	18.52	27.78	37.04	93.60	185 20
Carbon,........			3.10	3.10	6.20	9 30	12 40	31.00	62 00
Silicic Acid and Silicates,........			1.40	1.40	2.80	4 20	5.60	14 00	28.00
Water as Moisture........			13.61	13.61	27.22	40.83	54 44	136.10	272.20
Sulphates of Magnesia and Soda, Salts of Iron and loss,........			2.50	2.50	5 00	7.50	10.00	25.00	50.00

The most important fertilizing agents existed in the following proportions :

Free Trihydrated Phosphoric Acid,........	**1.37**	**1.37**	**2 74**	**4.11**	**5.48**	**13.70**	**27.40**
Soluble Phosphate of Lime,........	**15 56**	**12.56**	**31.12**	**46.68**	**62.24**	**155.60**	**311.20**
Insoluble Phosphate of Lime, (Bone Earth)........	**18.20**	**18.20**	**36.40**	**54.60**	**72.80**	**182.00**	**364.00**
Bihydrated Sulphate of Lime, (Gypsum)........	**44.26**	**44.26**	**88.52**	**132.96**	**177.04**	**442.60**	**885.20**

ANALYSIS 17. MEAN OF THE CHEMICAL EXAMINATIONS OF SAMPLES OF RHODES' SUPER-PHOSPHATE OF LIME, FROM SAVANNAH.

			100 parts contain,....	100 pounds contain pounds, ...	200 pounds contain pounds, ...	300 pounds contain pounds, ...	400 pounds contain pounds, ...	1,000 pounds contain pounds, ...	1 Ton of 2,000 pounds contain pounds,....
Free Trihydrated Phosphoric Acid 2.02	Phosphoric Acid,		1.47	1.47	2.94	4.41	5.88	14.70	29.40
	Water,		0.55	0.55	1.10	1.65	2.20	5.50	11.00
Soluble Phosphate of Lime 16.01	Metaphosphate of Lime 13.35	Phosphoric Acid,	9.61	9.61	19.22	28.83	38.44	96.10	192.20
		Lime,	3.74	3.74	7.48	11.22	14.95	37.40	74.80
	Water, 2.66	Water..	2.66	2.66	5.32	7.98	10.64	26.60	53 20
Insoluble Basic Phosphate of Lime (Bone Earth) 17.46	Phosphoric Acid,		8.03	8.03	16.06	24.09	32.12	80.30	150.60
	Lime,		9.44	9.44	18.88	28.32	37.76	94.40	188.80
Bihydrated Sulphate of Lime Gypsum, 44.31	Sulphuric Acid,		20.61	20.61	41.22	61.83	82.44	206.10	112.20
	Lime,		14.42	14.42	28.84	43.26	57.68	144.20	288 40
	Water,		9.28	9.28	18.56	27.84	37.12	92.80	185.60
Carbon,			2.55	2.55	5 10	7.65	10.20	25.50	51.00
Silicic Acid and Silicates,			1.10	1.10	2 20	3.30	4.40	11.00	22.00
Sulphates of Magnesia, Soda, Salts of Iron and loss,			2.29	2.29	4.58	6.87	9.16	22.90	45.80
Water as Moisture,			14.21	14.21	28.42	42.63	56.84	142.10	284.20

The principal Fertilizing agents existed in the following proportions:

Free Trihydrated Phosphoric Acid,	2.02	2.02	4.04	6.06	8.08	20.20	40.40
Insoluble Phosphate of Lime,	16.01	16.01	32.02	48.03	64.03	160.10	320.20
Insoluble Basic Phosphate of Lime, (Bone Earth,)	17.47	17.47	34.94	52.41	69.88	174.70	349.40
Bihydrated Sulphate of Lime, (Gypsum),	44.31	44.31	88.62	132.93	177.24	443.10	888.20

ANALYSIS 18. MEAN OF CHEMICAL EXAMINATIONS OF SAMPLES OF RHODES' SUPER-PHOSPHATE OF LIME, FROM AUGUSTA AND SAVANNAH.

	100 parts contain,....	100 pounds contain pounds, ...	200 pounds contain pounds, ...	300 pounds contain pounds, ...	400 pounds contain pounds, ...	1,000 pounds contain pounds, ...	1 Ton of 2,000 pounds contain pounds,....
Free Trihydrated Phosphoric Acid 2.01 — Phosphoric Acid,..................	1.46	1.46	2.92	4.38	5.84	14.60	29.20
— Water,..........................	0.55	0.55	1,10	1.65	2.20	5.50	11.00
Soluble Phosphate of Lime 15.59 — Metaphosphate of Lime 13.21 — Phorphoric Acid,	9.33	9.33	18.66	27.99	37.32	93.30	186.60
— Lime,..........	3.88	12.88	7.66	11.64	15.52	38.80	77.60
— Water, 2.38 — Water, ...	2.38	12.38	4.76	7.44	9.52	23 80	47.60
Insoluble Phosphate of Lime, Bone Earth, 17.15 — Phosphoric Acid,.....................	7.88	7.88	15.76	23.64	31.52	78.80	157.60
— Lime,..............................	9.27	9 27	18.54	27.81	37.08	92.70	185 40
Bihydrated Sulphate of Lime (Gypsum), 42 95 — Sulphuric Acid,.......................	20.29	20.29	40.58	60.87	81.16	202.90	405.80
— Lime, ...	14.20	14.20	28.40	42.60	56.80	142.00	284.00
— Water,.............................	8.46	8.46	16.92	25.38	33.84	84.60	169.20
Carbon,...	2.80	2.80	5.60	8.40	11.20	28.00	56.00
Silicic Acid and Silicates,...............................	1.15	1.15	2.30	3.45	4.60	11.20	23.00
Sulphates of Magnesia, Soda, Iron Salts and Loss,...................	2.95	2.95	5.90	8.85	11.80	29.50	59.00
Water as Moisture,..	15 08	15.08	30.16	45.24	60.32	150.80	301.60
The principal Fertilizing agents existed in the following proportions:							
Free Trihydrated Phosphoric Acid,................................	2.01	2.01	4.02	6.03	8.04	20.10	40.20
Soluble Phosphate of Lime,..	15.59	15.59	31.18	46.77	62.36	155.90	311.80
Insoluble Phosphate of Lime, (Bone Earth,)........................	17.15	17.15	34.30	51.45	68.60	171.50	343.00
Bihydrated Sulphate of Lime, (Gypsum),............................	42.95	42.95	85.90	128.85	171.80	429.50	859.00

ıe individual constituents were determined in several ›les of Rhodes' Superphosphate, from Augusta and ›nnah, with the following results:

	ANALYSIS 19.				ANALYSIS 20.			
	100 pounds contain..	200 pounds contain..	300 pounds contain..	1 Ton of 2000 pounds contain,............	100 pounds contain..	200 pounds contain..	300 pounds contain..	1 Ton of 2000 pounds contain............
Phosphoric Acid,............	17.79	35.58	53.37	355.80	18.77	37.54	56.31	375.40
Sulphuric Acid.............	22.28	44.56	66.84	445.60	23.92	47.84	71.76	478.4
Lime,......................	26.41	52.82	79.23	528.20	24.22	48.44	72.66	484.4
Water chemically combin'd,	11.64	23.28	34.92	232.80				
Water as Moisture..........	16.84	33.68	50.52	336 80				

	ANALYSIS 21.				ANALYSIS 22.			
	100 pounds contain..	200 pounds contain..	300 pounds contain,..	1 Ton of 2,000 pounds contain,............	100 pounds contain,..	200 pounds contain..	300 pounds contain..	1 Ton of 2000 pounds contain............
Phosphoric Acid,............	20.33	40.66	60.99	406.60	18.17	36.34	54.51	363.40
Sulphuric Acid.............	21.84	43.68	65.52	436.80	22.28	44.56	66.84	668.40
Lime,......................	26.48	52.96	79.44	529.60	23.00	46.00	69.00	690.00
Water chemically combin'd,	11.99	23.98	35.97	239.80				
Water as Moisture..........	13.61	27.22	40.83	272.20				

	ANALYSIS 23.				ANALYSIS 24.			
	100 pounds contain..	200 pounds contain..	300 pounds contain..	1 Ton of 2000 pounds contain,............	100 pounds contain..	200 pounds contain..	300 pounds contain..	1 Ton of 2000 pounds contain............
Phosphoric Acid,............	21.19	42.38	63.57	423.80	19.37	38.74	58.11	387.40
Sulphuric Acid.............	20.92	41.84	62.76	418.40	20.80	41.60	62.40	416.00
Lime,......................	24.94	49.88	84.82	498.80	27.69	55.38	83.07	553.80
Water chemically combin'd,					12.50	25.00	37.50	250.00
Water as Moisture..........					14.80	29.60	44.40	296.00

2. AMERICAN GUANO.—Samples of American Guano, from Jarvis & Baker's Islands, offered for sale in Augusta, yielded upon chemical analysis, the following results.

The Guano presented a reddish-brown color and consisted of a loose pulverized portion, and large lumps, varying in size and weight from a few grains to several pounds.

The lumps were hard, being with difficulty broken. In the state in which I examined this Guano, it was unfit for agricultural purposes. These hard lumps, although rich in Phosphate of Lime, would exert but little effect upon plants, on account of their insolubility. The lumps of American Guano should always be crushed before it is offered for sale.

ANALYSIS 25.—AMERICAN GUANO, (loose pulverized portion.)

	100 parts contain...	100 pounds contain pounds,...	200 pounds contain pounds,...	300 pounds contain pounds,...	400 pounds contain pounds...	1000 pounds contain pounds,...	1 Ton of 2000 pounds contain pounds,...
Phosphate of Lime	50.150	50.150	100.300	150.450	200.600	501.50	1003.00
Carbonate of Lime	1.750	1.750	3.500	5.250	7.000	17.50	35.00
Sulphate of Lime	3.890	3.890	7.780	11.770	15.560	38.90	77.80
Ammonia	0.238	0.238	0.476	0.714	0.952	2.38	4.760
Organic Matters, rich in Carbon	7.212	7.212	14.424	21.636	28.848	72.12	144.24
Silicates Insoluble in Hydrochloric Acid	2.890	2.890	5.780	8.670	11.560	28.90	57 80
Sand	0.375	0.375	0.750	1.125	1.500	3.75	7.50
Water as Moisture	30.300	30.300	60.600	90.900	121.300	303.00	606.00
Chlorides & Sulph. of Potassa, Ammonia, Soda & loss	2.289	2.289	4.578	6.867	9.156	22.89	45.78

ANALYSIS 26—AMERICAN GUANO, (hard lump portion.)

	100 parts contain....	100 pounds contain pounds,...	200 pounds contain pounds,...	300 pounds contain pounds ...	400 pounds contain pounds,...	1000 pounds contain pounds,...	1 Ton of 2000 pounds contain pounds....
Phosphate of Lime	59.00	59.00	118.00	177.00	236.00	590.00	1180.00
Carbonate of Lime	2.90	2.90	5.80	8.70	7.60	29.00	58.00
Sulphate of Lime	2.71	2.71	5.42	8.13	10.84	27.10	54.20
Ammonia	0.15	0.15	0.30	0.45	0.60	1.50	3.00
Organic Matters, rich in Carbon	9.19	9.19	18.38	27.57	36.76	91.90	183.80
Silicates Insoluble in Hydrochloric Acid	0.79	0.79	1.58	2.37	3.16	7.90	15.80
Sand	—	—	—	—	—	—	—
Water as Moisture	22.60	22.60	45.20	135.60	90.40	226.00	452.00
Chlorides and Sulphate of Potassa, Iron, Alumina, Soda, Silicates, Soluble in Acid and loss	1.75	1.75	3.50	10.50	7.00	17.50	35.00

ANALYSIS 27.—AMERICAN GUANO—(Mixture of the Loose and Lump, representing the average composition of the Fertilizer.)

	100 parts contain....	100 pounds contain pounds,........	200 pounds contain pounds,........	300 pounds contain pounds,........	400 pounds contain pounds,........	1000 pounds contain pounds,........	1 Ton of 2000 pounds contain pounds...
Phosphate of Lime,..................................	54.575	54.575	109.150	163.725	218.300	545.75	1091.50
Carbonate of Lime..................................	2.325	2.325	4.650	6.675	9.300	23.25	46.50
Sulphate of Lime..................................	3.303	3.303	6.606	9.909	13.212	33.03	66.06
Ammonia..................................	0.357	0.357	0.714	1.071	1.428	3.57	7.14
Organic Matters rich in Carbon..................	8.201	8.201	16.402	24.603	32.804	82.01	164.02
Silicates Insoluble in Hydrochloric Acid,............	1.840	1.840	3.680	5.520	7.360	14.40	36.80
Sand..................................	0.187	0.187	0.374	0.561	0.748	1.87	3.74
Water as Moisture..................................	26.450	26.450	52.900	79.350	105.800	264.50	529.00
Chlorides and Sulphates of Potassa, Iron, Alumina, Soda, Silicates, Soluble in Acid and loss,..........	2.014	2.014	4.028	6.032	8.156	20.14	40.

The following table will present the composition of various Commercial Manures, as determined by reliable Chemists.

TABLE 15.—COMPOSITION OF PHOSPHATIC GUANOS. *

	Phosphoric Acid, lbs.	Equivalent of Phosphoric Acid in Bone Phosphate of Lime, lbs.	Phosphate of Lime, lbs.	Lime, lbs.	Magnesia, lbs.	Chlorine, lbs.	Sulphuric Acid, lbs.	Organic Matter, lbs.	Phosphate of Alumina, lbs.	Sulphate of Lime, lbs.	Phosphate of Iron, lbs.	Sand, lbs.	Water, lbs.	Carbonic Acid and Ingredients not estimated, lbs.	Carbonate of Lime, lbs.
BROWN MEXICAN GUANO.															
100 pounds contain,	16.32	35.36	......	28.65	......	......	......	9.35	......	......	......	0.66	32.57	12.60	......
200 do do	32.64	70.72	......	57.30	......	......	......	18.70	......	......	......	1.32	65.02	25.20	......
300 do do	48.96	106.08	......	85.95	......	......	......	28.05	......	......	......	1.88	97.52	37.80	......
400 do do	65.28	141.74	......	114.60	......	......	......	37 40	......	......	......	2.64	130.04	50.40	......
500 do do	81.60	176.80	......	143.25	......	......	......	46.65	......	......	......	3.30	162.55	63.00	......
One Ton of 2,000 pounds contain,	326.40	707.20	......	57.30	......	......	......	187.00	......	......	......	13.20	650.20	126.00	......
BROWN MEXICAN GUANO.															
100 pounds contain,	16.68	36.14	......	28.21	......	......	......	12.53	......	......	......	0.21	29.28	13.09	......
200 do do	33.36	72.28	......	56.42	......	......	......	25.06	......	......	......	0.42	58.56	26.18	......
300 do do	50.04	108.42	......	84.63	......	......	......	37.59	......	......	......	0.63	87.84	39.27	......
400 do do	66.72	144.56	......	112.84	......	......	......	49.62	......	......	......	0.84	117.52	52.36	......
500 do do	83.40	120.70	......	141.05	......	......	......	62.65	......	......	......	1.05	146.40	65.45	......
One Ton of 2,000 pounds contain,	333.60	722.80	......	564.20	......	......	......	250.06	......	......	......	3.20	585.60	261.80	......
BROWN MEXICAN GUANO.															
100 pounds contain,	24.34	52.74	......	26.89	......	......	......	20.93	......	......	......	0.12	24.84	2.84	......
200 do do	48.68	105.48	......	53.78	......	......	......	41.86	......	......	......	0.24	47.68	4.68	......
300 do do	73.02	158.22	......	80.77	......	......	......	62.79	......	......	......	0.36	74.52	8.52	......
400 do do	97.36	210.86	......	107.56	......	......	......	83.72	......	......	......	0·48	99.36	11.36	......
500 do do	121.70	263.70	......	134.45	......	......	......	104.65	......	......	......	0.60	124.20	14.20	......
One Ton of 2,000 pounds contain,	486.80	1054.80	......	537.80	......	......	......	418.60	......	......	......	2.40	496.80	46.80	......
BROWN MEXICAN GUANO.															
100 pounds contain,	16.16	35.01	......	28.80	8.45	2.25	......	35.49	......	......	......	1.99	13.11	6.19	......
200 do do	32.32	70.02	......	41.72	9.70	4.50	......	70.98	......	......	......	2.18	26·22	12.38	......
300 do do	48.48	105.03	......	62.58	14.55	6.75	......	109.47	......	......	......	2.27	39.33	18.57	......
400 do do	64.64	140.04	......	83.44	19.40	9.00	......	141.76	......	......	......	4.36	52.44	24.76	......
500 do do	80.80	175.05	......	104.20	24.25	11.25	......	177.44	......	......	......	5.45	65.55	30.95	......
One Ton of 2,000 pounds contain,	323.2	709.20	......	317.20	97.00	22.50	......	709·80	......	......	......	10.90	262.20	123.8	......

* I have calculated and drawn up this table from the Analyses of Dr. Snowden Piggot, of Baltimore. See first Report of Philip T. Tyson, State Agricultural Chemist to the House of Delegates of Maryland. 1860, p.91, 100.

TABLE 15.—COMPOSITION OF PHOSPHATIC GUANOS—CONTINUED.

	Phosphoric Acid, lbs.	Equivalent of Phosphoric Acid in Bone Phosphate of Lime, lbs.	Phosphate of Lime, lbs.	Lime, lbs.	Magnesia, lbs.	Chlorine, lbs.	Sulphuric Acid, lbs.	Organic Matter, lbs.	Phosphate of Alumina, lbs.	Sulphate of Lime, lbs.	Phosphate of Iron, lbs.	Sand, lbs.	Water, lbs.	Carbonic Acid and Ingredients not estimated, lbs.	Carbonate of Lime, lbs.
BROWN MEXICAN GUANO.															
100 pounds contain,	31,22	67,64		30,78				11,06				trace	22,98	3,96	
200 do do.	62,44	135,58		61,56				22,12					45,96	7,92	
300 do do.	93,66	202,92		92,34				33,18					68,94	8,88	
400 do do.	124,88	270,56		123,12				44,24					91,92	15,84	
500 do do.	156,10	228,20		153,90				55,30					114,90	18,80	
One Ton of 2,000 pounds containn,	624,40	1353,80		615,60				221,20					459,60	79,20	
DARK SOUTH AMERICAN IRON GUANO.					Phosphate of Magnesia,										
100 pounds contain,			9,01		2,86			22,92			19,68	19,68	16,06	2,33	5,95
200 do do.			18,02		5,72			45,84			54,38	39,36	33,12	4,66	11,90
300 do do.			27,03		8,58			68,76			81,75	59,04	48,18	6,99	17,85
400 do do.			36,04		11,44			91,68			108,76	78,72	64,24	9,32	23,80
500 do do.			45,05		14,30			114,60			135,95	98,40	80,30	11,65	29,70
One Ton of 2,000 pounds contain,			180,20		57,20			458,40			543,80	393,60	321,20	46,60	59,50
PATAGONIAN IRON GUANO.															
100 pounds contain,	5,51		4,85	5,56			4,21	31,34	6,38	7.98		34,45	31,34		
200 do do.	11,02		9,70	11,12			8,42	62,68	12,76	15 96		68,90	62,68		
300 do do.	16,53		14,55	16,68			12,63	94,02	19,14	23,94		103,35	93,02		
400 do do.	22,04		19,40	21,24			16,84	125,36	25,52	31,92		137,80	125,36		
500 do do.	27,05		24,25	27,80			21,05	156,70	31,90	39,90		172,25	156,70		
One Ton of 2,000 pounds contain,	100,20		97,00	111,20			84,20	626,80	127,60	159,60		689,00	626,80		
AFRICAN GUANO, SALDANHA BAY.															
100 pounds contain,	17,54	38,10		9,56				7,89				39,59	17,06	8,46	
200 do do.	35,08	76,20		19,12				15,78				79,18	34,12	16,92	
300 do do.	52,62	114·40		28,68				23,77				118,77	51,28	25,38	
400 do do.	140,32	112,40		38,24				31,56				158,36	98,24	33,84	
500 do do.	190,40	190,50		47,80				39,45				197,95	85,30	42,30	
One Ton of 2,000 pounds ocntain,	350,80	752,00		191,20				157,80				791,80	341,30	169,20	

TABLE 15—CONTINUED.

	Phosphoric Acid,	Equivalent of Phosphoric Acid in Bone Phosphate of Lime,	Phosphate of Lime,	Lime,	Magnesia,	Chlorine,	Sulphuric Acid,	Organic Matter,	Phosphate of Alumina,	Sulphate of Lime,	Phosphate of Iron,	Sand,	Water,	Carbonic Acid and Ingredi nts not Estimated,	Carbonate of Lime,
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
BROWN AFRICAN GUANO, CAPE COLONY.															
100 pounds contain,	......	......	40,24	......	......	......	......	10,44	......	9,88	......	0,61	......	17,46	......
200 do do.	......	......	81 48	......	......	......	......	20,88	......	19,76	......	1,22	......	34,92	......
300 do do.	......	......	120,72	......	......	......	......	31,32	......	38,64	......	1,83	......	52,38	......
400 do do.	......	......	160,96	......	......	......	......	41,76	......	39,52	......	2,44	......	69,84	......
500 do do.	......	......	201,20	......	......	......	......	52,20	......	45,40	......	3,05	......	87,30	......
One Ton of 2,000 pounds contain,	......	......	804,80	......	......	......	......	208,80	......	197,60	......	12,20	......	349,20	......
JARVIS ISLAND GUANO					Phosphate of Magnesia										
100 pounds contain,	......	......	16,53	......	1,65	......	......	......	......	76,72	......	1,22	......	......	......
200 do po.	......	......	33,06	......	3,30	......	......	......	......	153,44	......	2,44	......	......	......
300 do do.	......	......	49,52	......	4,95	......	......	......	......	230,16	......	3,66	......	......	......
400 do do.	......	......	66,12	......	6,60	......	......	......	......	306,88	......	4,88	......	......	......
500 do do.	......	......	82,65	......	8,25	......	......	......	......	383,60	......	6,10	......	......	......
One Ton of 2,000 pounds contain,	......	......	330,60	......	33,00	......	......	......	......	1534,40	......	24,40	......	......	......
WHITE MEXICAN GUANO.					Magnesia										
100 pounds contain,	37,12	81,03	......	43,91	trace	trace	trace	7,10	......	......	......	0,11	3,80	7,25	......
200 do do.	74,24	162,06	......	87,82	......	......	......	14,20	......	......	......	0,22	7,60	14,50	......
300 do do.	111,36	243,09	......	131,73	......	......	......	21,30	......	......	......	0,33	11,40	21,75	......
400 do do.	148,48	324,12	......	175,64	......	......	......	28,40	......	......	......	0,44	15,20	29,00	......
500 do do.	185,60	405,15	......	219,55	......	......	......	35,50	......	......	......	0,55	19,00	36,25	......
One Ton of 2,000 pounds contain,	742,40	1620,60	......	878,20	......	......	......	142,00	......	......	......	1,10	76,00	72,50	......
COLUMBIAN GUANO.					Phosphate of Magnesia										
100 do do.	46,22	87,95	......	38,75	0,61	trace	1,96	8,95	......	4,21	0,35	0,63	2,34	......	......
200 do do.	92,44	175,90	......	77,50	1,22	......	3,92	17,90	......	8,42	0,70	1,26	4,68	......	......
300 do do.	138,66	263,85	......	116,25	1,83	......	5,88	26,63	......	12,63	1,05	1,89	7,02	......	......
400 do do.	184,88	351,80	......	155,00	2,44	......	7,84	35,80	......	16,84	1,40	2,52	9,36	......	......
500 do do.	231,10	439,75	......	193,75	3,05	......	9,80	44,75	......	20,05	3,50	3,15	11,40	......	......
One Ton of 2,000 pounds contain,	924,40	1759,00	......	775,00	12,20	......	39,20	179,00	......	84,20	7,00	12,60	46,80	......	......

TABLE 15—CONTINUED.

	Phosphoric Acid, ... lbs.	Equivalent of Phosphoric Acid in Bone Phosphate of Lime, lbs.	Phosphate of Lime, .. lbs.	Lime, ... lbs.	Magnesia, ... lbs.	Chlorine, ... lbs.	Sulphuric Acid, ... lbs.	Organic Matter, ... lbs.	Phosphate of Alumina, lbs.	Sulphate of Lime, ... lbs.	Phosphate of Iron, .. lbs.	Sand, ... lbs.	Water, ... lbs.	Carbonic Acid and Ingredients not Estimated, ... lbs.	Carbonate of Lime, .. lbs.
SOMBRERO GUANO.					Magnesia				Alumina,		Oxide of Iron,				
100 pounds contain,	34.65	75.04	......	44.66	1.56	0.35	......	7.07	4.97	......	2.03	0.69	......	......	......
200 do do.	69.30	150.08	......	89.32	3.12	0.70	......	14.14	9.94	......	4.06	1.38	......	......	......
300 do do.	103.95	225.12	......	133.98	4.68	1.05	......	21021	14.91	......	6.09	2.07	......	......	......
400 do do.	138.60	390.16	......	178.64	7.24	1.40	......	28.28	19.88	......	8.12	2.76	......	......	......
500 do do.	173.25	375.20	......	223.30	8.80	1.76	......	35.35	24.85	......	10.15	3.45	......	......	......
One Ton of 2,000 pounds contain,	693.00	1500.80	......	893.20	31.20	7.00	......	141.40	99.40	......	40.60	13.80	......	......	......
SOMBRERO GUANO.															
100 pounds contain,	36.80	79.73	......	41.62	0.35	0.35	......	7.07	4.13	......	4.97	2.76	......	......	......
200 do do.	73.60	159.46	......	83.04	0.70	0.70	......	14.14	8.26	......	9.94	1.38	......	......	......
300 do do.	110.40	239.19	......	124.56	0.95	0.95	......	21.21	12.39	......	14.91	2.07	......	......	......
400 do do.	147.20	308.92	......	169.08	1.04	1.40	......	28.28	16.52	......	19.88	2.76	......	......	......
500 do do.	184.00	398.65	......	207.60	1.75	1.75	......	35.35	20.65	......	24.85	3.45	......	......	......
One Ton of 2,000 pounds contain,	736.00	1594.60	......	830.40	7.00	7.00	......	141.40	82.60	......	49.70	13.80	......	......	......
SOMBRERO GUANO.															
100 pounds contain,	35.62	77.75	......	40.27	1.07	......	......	12.27	......	......	......	0.51	......	......	......
200 do do.	71.24	155.50	......	80.54	2.14	......	......	24.54	......	......	......	1.02	......	......	......
300 do do.	106.86	232.25	......	120.81	3.21	......	......	36.81	......	......	......	2.04	......	......	......
400 do do.	142.48	300.00	......	161.08	4.28	......	......	49.08	......	......	......	2.04	......	......	......
500 do do.	178.10	388.75	......	201.35	5.35	......	......	61.35	......	......	......	2.55	......	......	......
One Ton of 2,000 pounds contain,	712.40	1555.00	......	805.40	21.40	......	......	245.40	......	......	......	10.20	......	......	......
NEVASSA GUANO.									Alumina and Oxide of Iron						
100 pounds contain,	31.66	68.49	......	29.66	......	......	......	12.72	21.50	......	......	4.11	......	......	......
200 do do.	63.32	136.98	......	59.32	......	......	......	25.44	43.00	......	......	8.22	......	......	......
300 do do.	89.98	205.37	......	88.98	......	......	......	28.16	64.50	......	......	12.33	......	......	......
400 do do.	120.64	273.96	......	118.64	......	......	......	50.88	86.00	......	......	16.44	......	......	......
500 do do.	158.30	342.45	......	148.30	......	......	......	63.60	107.50	......	......	20.55	......	......	......
One Ton of 2,000 pounds contain,	633.20	1369.8	......	593.20	......	......	......	254.40	430.00	......	......	82.20	......	......	......
EL-MONTANA GUANO.					Phosphate of Magnesia,										
100 pounds contain,	27.78	60.17	46.18	35.06	8.65	......	17.61	5.11	......	35.41	......	0.86	......	3.79	......
200 do do.	55.56	120.34	92.36	70.12	17.30	......	35.22	10.22	......	70.82	......	1.72	......	7.58	......
300 do do.	83.34	180.51	138.54	105.18	25.95	......	52.83	20.44	......	106.23	......	2.50	......	11.37	......
400 do do.	111.12	240.68	184.72	140.24	34.60	......	77.44	15.33	......	141.54	......	3.52	......	15.16	......
500 do do.	148.90	300.85	230.90	175.30	43.25	......	81.05	25.53	......	177.05	......	4.30	......	18.95	......
One Ton of 2,000 pounds contain,	555.50	1203.40	923.60	701.20	173.00	......	352.20	102.20	......	708.20	......	17.20	......	75.80	......

TABLE 16—AMMONIA—PHOSPHATIC GUANO.

	Combined Water, Organic Matter and Ammoniacal Salts, lbs.	Ammonia, lbs.	Phosphoric Acid, lbs.	Sulphuric Acid, lbs.	Carbonic Acid, lbs.	Chlorine, lbs.	Lime, lbs.	Earthy Phosphates, lbs.	Excess of Lime, lbs.	Magnesia, lbs.	Potassa and Soda, lbs.	Sand and Silica, lbs.	Water as Moisture, lbs.	Not Estimated, lbs.	Phosphate of Magnesia, lbs.
*CALIFORNIA GUANO.															
100 pounds contain	51.04	10.17	11.91	....	....	....	6.11	....	....	....	....	3.68	16.73	11.63	....
200 do do	102.08	20.34	23.82	....	....	....	12.22	....	....	....	....	7.36	32.26	23.26	....
300 do do	153.12	30.51	35.73	....	....	....	18.33	....	....	....	....	11.04	49.89	34.89	....
400 do do	204.16	40.68	47.64	....	....	....	24.44	....	....	....	....	14.72	66.52	46.52	....
One Ton of 2000 pounds contain	255.20	50.80	49.55	....	....	....	30.55	....	....	....	....	18.40	83.15	58.15	....
*CALIFORNIA GUANO.	1020.20	203.40	238.20	....	....	....	122.20	....	....	....	....	36.80	332.60	232.60	....
100 pounds contain															
200 do do	38.45	6.35	16.29	....	....	....	15.55	....	....	....	....	16.10	....	9.00	4.61
200 do do	76.90	12.70	32.58	....	....	....	31.10	....	....	....	....	32.20	....	18.00	9.22
300 do do	115.35	19.05	48.89	....	....	....	46.60	....	....	....	....	48.30	....	27.00	13.83
400 do do	153.80	25.40	65.16	....	....	....	62.20	....	....	....	....	64.40	....	36.00	18.44
500 do do	192.25	31.85	81.44	....	....	....	77.75	....	....	....	....	80.50	....	45.00	23.05
One Ton of 2000 pounds contain	769.00	127.00	325.80	....	....	....	311.00	....	....	....	....	322.00	....	180.00	92.20
(1) CALIFORNIA GUANO.															
100 pounds contain	39.20	10.00	11.73	4.94	....	....	9.67	....	....	....	2.50	2.50	27.34	....	....
200 do do	78.40	20.00	23.46	9.88	....	....	19.34	....	....	....	5.00	6.00	54.68	....	....
300 do do	87.60	30.00	35.19	14.82	....	....	29.01	....	....	....	7.50	7.50	82.02	....	....
400 do do	156.80	40.00	46.92	19.76	....	....	38.68	....	....	....	10.00	10.00	109.36	....	....
500 do do	191.00	50.00	58.63	24.70	....	....	48.35	....	....	....	12.50	12.50	136.70	....	....
One Ton of 2000 pounds contain	784.00	200.00	234.60	49.30	....	....	193.40	....	....	....	50.00	50.00	546.80	....	....
(1) CALIFORNIA GUANO.															
100 pounds contain	38.75	10.06	11.56	4.94	....	....	9.36	....	....	....	2.50	2.52	27.60	....	....
200 do do	77.50	20.12	23.12	9.88	....	....	18.72	....	....	....	5.00	5.04	55.20	....	....
300 do do	116.25	30.18	34.68	14.82	....	....	28.08	....	....	....	7.50	7.56	82.80	....	....
400 do do	155.00	40.24	46.20	19.76	....	....	37.44	....	....	....	10.00	10.08	110.40	....	....
500 do do	193.75	50.30	57.80	24.70	....	....	46.80	....	....	....	12.50	12.60	138.00	....	....
One Ton of 2000 pounds contain	775.00	201.20	231.20	98.80	....	....	187.20	....	....	....	50.00	50.40	552.00	....	....

*By A. Snowden Piggot, of Baltimore. First Agricultural Report of Philip T. Tyson—pp. 99-100.
(1) Professor S. W. Johnson, in his work: "Peat, Muck, and Commercial Manures."

TABLE 16—CONTINUED.

	Combined Water, Organic Matter and Ammoniacal Salts, lbs.	Ammonia, lbs.	Phosphoric Acid, lbs.	Sulphuric Acid, lbs.	Carbonic Acid, lbs.	Chlorine, lbs.	Lime, lbs.	Earthy Phosphates, lbs.	Excess of Lime, lbs.	Magnesia, lbs.	Potassa and Soda, lbs.	Sand and Silica, lbs.	Water as Moisture, lbs.
(2) SALDANHA BAY GUANO.													
100 pounds contain	21.69	......	......	1.94	2.61	0.73	......	56.99	3.70	0.68	3.40	0.68	7.58
200 do do	64.38	......	......	3.88	5.22	1.56	......	113.98	7.40	1.36	6.89	1.36	16.16
300 do do	65.07	......	......	4.82	7.88	2.19	......	170.97	11.10	2.04	10.20	2.04	23.74
400 do do	86.76	......	......	7.75	10.44	2.92	......	237.96	14.80	2.72	13.60	2.72	30.32
500 do do	108.45	......	......	9.70	13.05	3.65	......	289.95	18.50	3.40	17.00	3.40	37.90
One Ton of 2,000 pounds contain	613.80	......	......	38.80	52.20	15.6	......	1239.80	74.00	13.80	68.00	13.60	161.60
(2) SALDANHA BAY GUANO.													
100 pounds contain	15.51	......	......	1.31	0.68	4.55	......	58.76	2.23	0.86	1.02	0.99	18.09
200 do do	31.02	......	......	2.62	1.36	1.10	......	117.52	4.46	1.72	2.04	1.98	36.18
300 do do	46.53	......	......	3.93	2.04	1.65	......	176.28	6.69	2.58	3.06	2.97	54.27
400 do do	62.04	......	......	5.24	2.72	2.25	......	235.04	8.92	3.44	4.08	3.96	72.36
500 do do	77.55	......	......	6.55	3.40	2.75	......	283.80	11.15	4.30	5.10	4.95	90.45
One Ton of 2,000 pounds contain	310.20	......	......	26.20	13.60	11.00	......	1175.20	44.60	17.20	20.40	19.80	180.90
(2) SALDANHA BAY GUANO.													
100 pounds contain	13.29	......	......	4.09	0.20	0.72	......	60.96	1.07	0.20	2.81	2.26	14.40
200 do do	26.58	......	......	8.18	0.40	1.44	......	121.92	2.14	0.40	5.62	4.52	28.80
300 do do	39.87	......	......	12.27	0.60	2.16	......	182.88	3.21	0.60	8.43	6.78	43.20
400 do do	53.16	......	......	16.36	0.80	2.88	......	243.84	4.28	0.80	11.24	9.04	57.60
500 do do	66.45	......	......	20.45	1.00	3.60	......	304.80	5.35	1.00	14.05	11.30	72.00
One Ton of 2,000 pounds contain	265.00	......	......	81.80	4.00	14.40	......	1219.20	21.40	4.00	56.20	45.20	288.00
(2) SALDANHA BAY GUANO.													
100 pounds contain	19.64	......	......	2.57	3.08	0.57	......	54.82	0.57	0.32	5.22	0.99	12.23
200 do do	59.28	......	......	5.14	6.16	1.14	......	108.64	1.14	0.64	10.44	1.98	24.44
300 do do	58.92	......	......	7.71	9.24	1.71	......	164.46	1.71	0.96	15.66	2.97	36.66
400 do do	78.56	......	......	10.28	12.32	2.28	......	219.28	2.28	1.28	20.88	3.96	48.88
500 do do	98.20	......	......	12.85	15.40	2.35	......	274.10	2.87	1.60	26.10	4.95	61.11
One Ton of 2,000 pounds contain	392.80	......	......	51.40	61.60	11.40	......	1096.40	11.40	6.40	104.40	19.80	244.40

(2) By Th. Way, of England. Journal of the Royal Agricultural Society of England, vol. x, Part 1 Liebig & Kopp's Report, vol. 3, p. 461.

TABLE 17. AMMONIA GUANO.

	Organic Substance and Ammonia Salts, lbs.	Ammonia, lbs.	Ammonia Potential, lbs.	Phosphoric Acid, lbs.	Phosphate of Lime Equivalent to the total Phosphoric Acid, lbs.	Sulphuric Acid, lbs.	Lime, lbs.	Magnesia, lbs.	Sesquioxide of Iron, lbs.	Potassa, lbs.	Soda, lbs.	Chloride of Sodium, lbs.	Sand and Silica, lbs.	Water, lbs.	Water and Organic Matter, lbs.
(1) PERUVIAN GUANO.															
100 pounds contain,	47.07	......	......	12.41	......	3.83	9.70	0.70	0.27	3.07	2.13	1.21	1.31	18.33	......
200 do do.	94.08	......	......	24.82	......	7.66	19.98	1.40	0.54	6.14	4.26	2.42	2.62	36.6.	......
300 do do.	141.12	......	......	37.23	......	11.49	29.10	2.10	0.81	9.21	6.39	3.63	3.93	54.99	......
400 do do.	188.16	......	......	49.64	......	15.32	38.80	2.80	1.08	12.28	8.52	4.84	5.24	73.32	......
500 do do.	235.20	......	......	62.05	......	19.15	48.50	3.50	1.35	15.35	10.65	6.05	6.55	91.65	......
One Ton of 2,000 pounds contain,	940.80	......	......	248.70	......	76.60	194.00	14.00	5.40	61.40	42.60	24.20	26.20	366.60	......
(1) PERUVIAN GUANO.															
100 pounds contain,	33.67	......	......	20.21	......	4.00	16.49	0.80	0.22	3.60	4.15	2.57	1.72	12.57	......
200 do do.	67.34	......	......	40.12	......	8.00	32.98	1.60	0.44	7.20	8.30	5.14	3.44	25.14	......
300 do do.	101.01	......	......	60.63	......	12.00	49.47	2.40	0.66	10.80	12.45	7.71	5.16	37.71	......
400 do do.	134.68	......	......	80.84	......	16.00	65.96	3.20	0.88	14.40	16.60	10.28	7.88	51.75	......
500 do do.	168.35	......	......	101.05	......	20.00	82.45	4.00	1.10	18.00	20.75	12.85	8.60	62.75	......
One Ton of 2,000 pounds contain,	673.40	......	......	404.20	......	80.00	329.80	16.00	4.40	72.00	83.00	51.40	34.40	251.40	......
(1) PERUVIAN GUANO.															
100 pounds contain,	46.61	......	......	14.47	......	4.54	11.47	0.62	0.23	3.22	0.91	2.66	2.79	12.50	......
200 do do.	93.22	......	......	28.74	......	9.08	22.94	1.24	0.46	6.44	1.82	5.32	5.58	25.00	......
300 do do.	139.83	......	......	43.11	......	13.52	34.41	1.86	0.69	9.66	2.73	7.98	8.37	37.50	......
400 do do.	186.44	......	......	57.48	......	18.16	45.88	2.48	0.92	12.88	3.64	10.69	11.16	50.00	......
500 do do.	233.05	......	......	61.85	......	22.70	57.35	3.10	1.15	16.10	4.55	11.30	13.95	62.50	......
One Ton of 2,000 pounds contain,	932.20	......	......	287.40	......	90.80	229.40	12.40	4.60	64.40	18.20	53.20	55.80	50.00	......
(1) PERUVIAN GUANO.															
100 pounds contain,	52.97	......	......	14.56	......	2.52	10.38	0.31	0.73	1.42	......	2.02	1.42	13.67	......
200 do do.	105.94	......	......	29.12	......	5.04	20.76	0.62	1.46	2.84	......	4.04	2.84	27.34	......
300 do do.	158.91	......	......	43.68	......	7.56	31.14	0.93	2.19	4.26	......	6.06	4.26	40.01	......
400 do do.	211.88	......	......	58.25	......	10.08	41.52	1.24	2.92	5.68	......	8.08	5.68	54.68	......
500 do do.	264.85	......	......	72.80	......	12.60	51.90	1.55	3.65	7.10	......	10.10	7.10	68.35	......
One Ton of 2,000 pounds contain,	1059.40	......	......	291.20	......	50.40	207.60	6.20	7.30	28.40	......	20.20	28.40	278.40	......
(2) PERUVIAN GUANO.															
100 pounds contain,	......	8.93	5.82	14.74	21.28	......	......	......	......	......	......	......	1.69	......	66.32
200 do do.	......	17.96	11.61	29.84	42.56	......	......	......	......	......	......	......	3.38	......	132.64
300 do do.	......	26.79	17.46	44.22	63.84	......	......	......	......	......	......	......	6.07	......	198.96
400 do do.	......	35.72	23.28	58.96	85.12	......	......	......	......	......	......	......	6.76	......	265.28
500 do do.	......	44.65	29.10	73.70	106.40	......	......	......	......	......	......	......	8.45	......	331.60
One Ton of 2,000 pounds contain,	......	179.60	116.40	94.802	425.60	......	......	......	......	......	......	......	33.50	......	1326.40

(1) Th. Way. Jour. of the Royal Agr'l. Society of Eng. X, Part 1, Liebig & Kopp's Annual Rep. v. 3, p. 461. (2) Prof. S. W. Johnson, "Peat, Muck and Com. Manures."

TABLE 17. CONTINUED.

	Organic Substance and Ammonia Salts, lbs.	Ammonia, lbs.	Chloride of Ammonium, lbs.	Phosphoric Acid, lbs.	Phosphate of Lime Equivalent to the total Phosphoric Acid, lbs.	Urate of Ammonia, lbs.	Oxalate of Ammonia, lbs.	Phosphate of Ammonia, lbs.	Phosphate of Magnesia and Alumina, lbs.	Sulphate of Potash, lbs.	Sulphate of Lime, lbs.	Chloride of Sodium, lbs.	Sand and Silica, lbs.	Water, lbs.	Carbonate of Lime, lbs.	Urea, lbs.	Oxalate of Lime, lbs.
(2) PERUVIAN GUANO.																	
100 pounds contain,	51.46	15.94	......	14.08	31.69	......	......		......	......	......	......	2.66	12.70	......	......	......
200 do do	102.92	31.96	......	28.16	63.38	......	......		......	......	......	......	5.32	25.40	......	......	......
300 do do	154.38	47.94	......	42.24	95.07	......	......		......	......	......	......	7.98	38.10	......	......	......
400 do do	205.74	63.92	......	56.52	126.76	......	......		......	......	......	......	10.64	50.80	......	......	......
500 do do	257.39	79.90	......	70.40	158.43	......	......		......	......	......	......	13.30	63.50	......	......	......
One Ton of 2,000 pounds contain,	1029.20	319.60	......	281.60	633.80	......	......	......	......	......	......	......	53.20	127.00	......	......	......
(3) PERUVIAN GUANO.				Sesqui Carbonate of Am'onia,	Sulphate of Ammonia,												
100 pounds contain,	41.73	......	......			15.27	0.60	5.50	1.25	7.90	9.00	5.00	3.25	......	......	5.00	......
200 do do	83.46	......	......			30.54	1.20	11.00	2.50	15.80	18.00	10.00	4.50	......	......	10.00	......
300 do do	125.19	......	......			45.81	1.80	16.50	3.75	23.70	27.00	15.00	5.75	......	......	15.00	......
400 do do	206.92	......	......			61.08	2.40	22.00	5.00	30.60	36.00	20.00	9.00	......	......	20.00	......
500 do do	208.75	......	......			76.35	3.00	27.50	6.25	39.50	45.00	25.00	12.35	......	......	25.00	......
One Ton of 2,000 pounds contain,	834.60	......	......			305.40	12.00	110.00	25.00	158.00	180.00	100.00	45.00	......	......	100.00	......
(3) PERUVIAN GUANO.																Sulphate of Soda,	
100 pounds contain,	18.47	9.80	3.00	1.00	2.00	14.73	3.23	14.32	4.50	6.00	22.00	......	1.25	8.50	......		1.00
200 do do	36.94	19.60	6.00	2.00	3.00	29.44	6.46	28.64	9.00	12.00	44.00	......	2.50	17.00	......		2.00
300 do do	55.41	29.40	9.00	3.00	6.00	44.16	9.60	42.96	13.50	18.00	66.00	......	3.75	25.50	......		3.00
400* do do	73.88	39.20	12.00	4.00	8.00	58.88	12.92	57.28	14.00	24.00	88.00	......	5.00	34.00	......		4.00
500 do do	92.35	49.00	15.00	5.00	10.00	73.60	16.15	71.60	22.50	30.05	110.00	......	6.25	42.50	......		5.60
One Ton of 2,000 pounds contain,	369.40	196.00	60.00	10.00	40.00	274.40	64.60	286.40	80.00	120.00	440.00	......	25.00	170.00	......		20.00
(4) PERUVIAN GUANO.																	
100 pounds contain,	8.26	12.07	2.25	0.80	......	12.20	17.73	6.90	11.63	4.00	20.16	0.40	1.68	4.31	1.65	4.92	1.30
200 do do	16.52	25.14	4.50	1.60	......	24.40	35.46	13.80	23.26	8.00	40.32	0.80	3.36	8.62	3.30	9.84	2.60
300 do oo	24.78	36.21	6.75	2.40	......	36.60	58.02	20.70	34.89	12.00	60.48	1.20	5.04	12.93	4.95	14.76	3.90
400 do do	33.04	48.28	9.00	3.20	......	48.80	70.92	27.60	46.52	16.00	80.64	1.60	6.72	17.24	6.60	19.68	5.20
500 do do	41.30	60.35	12.25	4.00	......	61.00	81.65	38.50	58.15	20.00	100.80	2.00	8.40	21.55	8.25	24.60	6.50
One Ton of 2,000 pounds contain,	165.20	251.40	45.00	16.00	......	244.00	354.00	138.00	232.60	80.00	403.20	8.00	33.60	86.20	33.00	98.40	26.00

(2) Prof. S. W. Johnson, "Peat, Muck and Commercial Manures."

(3) Andrew Ure, Dictionary of Arts, Mauufacturers and Mines, Vol. 2d, p. 966. (4) Oellacher.

A careful comparison of the Chemical constitution of these commercial manures, demonstrates that each constituent varies in amount, within wide limits, thus, in Phosphatic Guanos, the most valuable ingredient, the Phosphate of Lime, varies from 330 pounds to 1759 pounds in the Ton of 2000 pounds; in some varieties of the Phosphatic Guanos, presenting very nearly the same general appearance with the best varieties, Phosphoric Acid is combined with Iron and Alumina, and not with lime: in the Ammonia—Phosphatic guanos, the Ammonia and Organic matters capable of generating Ammonia and the Phosphate of Lime, vary within wide limits, not only in guanos from different localities, but even in Guanos said to be from the same locality; and in the Peruvian Guano, not only do the individual constituents, the Phosphates, the Alkaline Salts, the organic matters and the Ammonia, vary within wide limits, but what is of considerable importance in the action of the guano upon the soil and plants, the state of combination of the various constituents, especially of the organic matters, vary within wide limits.

The following questions, highly important to the planter demand an answer.

Do the venders of these fertilizers inform the Planters of these variations?

Do the venders of fertilizers fix their prices in accordance with these variations, and with the actual value of the fertilizing principles?

The actual value of these fertilizers may be ascertained by determining the agricultural value of the individual constituents.

The actual or agricultural value to the planter is determined by the increased yield which these manures are capable of producing.

The experiments upon the increased yield which these fertilizers are capable of producing in Georgia, are not yet completed, for the present purpose therefore we will avail ourselves of the labors of English and American Chemists

in countries where definite experiments have determined the actual value of the individual constituents. According to Professor Johnson, the principle constituents of fertilizers possess the following values.

Soluble Phosphoric Acid . .	14	cents per pound.
Insoluble " " "	4½	" " "
Insol. Phosphate of Lime (Bone Earth)	2.	" " "
Ammonia	14.	" " "

If now we apply these numbers, which I am convinced are too high rather than too low for the great body of our Georgia lands, we will find that the actual values of commercial fertilizers differ in many cases widely from the values at which they are offered in the Georgia market; we will find that the commercial value is often above and never below the actual value; and we will find that inferior articles frequently command as high prices as the very best. An examination of the manufactured compounds, leads to similar conclusions.

With reference to manipulated compounds it would seem that every panter who reflected for one moment, would see that if the planter is compelled to purchase commercial fertilizers he had better make his own manipulations and compounds for these sufficient reasons.

There must be some profit upon each compound introduced into the mixture. If there be not some profit over and above the actual cost of the guanos and other ingredients entering into the manipulated manure, how do the manufacturers of these compounds manage to make such profits? If there be no profits made upon each ingredient, why are our papers loaded with brazen advertisements, each claiming to be "the best compound in the world?" If the original guanos and other materials used in these manipulated compounds are sold at too high a price by the importers, and if a handsome profit is made on each ingredient, is it not evident that the planter would do better to make his own compounds? and is it not evident that the planter would do better still to use the resources for the

regeneration of his land, which Providence has placed upon his own soil, and abandon these imported articles which are liable to great variations, until at least some arrangement is made by the State to compell the venders of these compounds to submit them to the constant examination of competent chemists?

Well established facts, prove that not only manipulated manures, but also Guanos are in some instances greatly adulterated. To substantiate these propositions we have selected the following facts which rest upon the testimony of responsible and competent men. Professor Philip T. Tyson, State Agricultural Chemist of Maryland, in his recent able report to the House of Delegates of Maryland, thus notices the adulterations of Guanos and manufactured fertilizers.

"It appears that the adulteration of Guanos, especially the Peruvian is very extensively practiced in Great Britain, and I regret to be obliged to believe that frauds of this kind, are also perpetrated in our own country.

In order to protect our farmers against such impositions, the system of inspection of guano was instituted in our State, and it has doubtless been a means of protection to a considerable extent.

But yet, it appears from the testimony of many farmers that they have had palmed upon them sometimes inferior or adulterated Guano, with the inspectors mark upon the bags. Gentlemen have informed me, that boatmen who have brought them Peruvian Guano, have offered to furnish them with good new bags, for the Guano bags containing the inspectors mark! Suspecting however that they were wanted for dishonest uses, they refused to part with them.

There is a peculiar earth on the southern slope of Ham stead Hill near the eastern limit of Baltimore, of which I have been informed large quantities have been, and may still continue to be secretly carted into the city. There being no conceiveable honest use, for which this material

can be brought into the city, and it being very similar in color to Peruvian Guano, it was reported to be used to adulterate that article, the mixture being put up and sold in old guano bags containing the inspectors mark! Some months since the inspector called the attention of the police to the affair, who arrested parties carting away this earth in Guano bags during the night. The arrest was evidently made at an injudicious time, because upon examination the bags were found to contain only earth. If however, the parties had been watched until they had taken it to their mixing depot, and completed the crime, they might possibly have been properly punished.

During the late season of active field work, I endeavored to collect for examination samples of Guano, ground bones and artificial fertilizers, which had been purchased and received by my farming friends. Finding but few kinds in their possession, I requested that samples might be forwarded me whenever they shall again purchase. Among others I got in person a sample of guano from Col. John S. Sellman, of Anne Arundel county, which being sold for Mexican A. A. should have contained Phosphsric Acid equal to 55 per cent. or more, of Phosphate of Lime, and yet the analysis showed but 36 per cent. In this case the Colonel paid for 50 per cent. or more, Phosphate of Lime than was implied in the purchase, and if the deficiency had not been discovered, he would have sueffred a still greatei loss, by not applying a proper dose of the phosphate to his soil. How much of this Guano was sold and used by farmers, I have no means of knowing."* * * * Professor Johnson determined the value of several fertilizers.

1st. Mapis Super-phosphate from Newark, N. J. In 1852 its calculated value was $44. In 1857 it had degenerated to $15, owing to the introduction of worthless matter and the total absence of soluble Phosphoric Acid.

2d. Another article called Mapes Nitrogenized possessed a value by calculation in 1856, of $21; and in 1857 one sample proved to be worth $14.50, and a second $12.50, so that it seems to be going down pretty fast.

3d. The name of DE BURG's Super Phosphate of Williamsburg, Long Island, so familiar to farmers from advertisements proved to be worth, in 1852, $32 ; in 1856, $36.25, and in 1857 it had fallen to $21.50.

4th. COE'S SUPERPHOSPHATE, from Middletown, Conn., has proven more uniform in composition as shown by seven analyses between 1854 and 1857, its value being as follows: $33.75; $33. $41. $33. $35. and $33.25.

5th. Professor Johnson calculated the value of RHODES SUPER-PHOSPHATE of Lime, (a Baltimore article,) from three analyses to be 32.25, and his results, he remarks, do not seriously differ from those of Dr. Higgins and Bickell.

JOURDANS SUPER-PHOSPHATE.—Since this chapter was placed in the hands of the printer, Dr. Piggot has reported to me the results of analysis of two samples of an article under the above name. They were furnished by Maj. Edward Wilkens, of Kent. county.

The first was purchased in 1858, and was used with good effect by many farmers in that county. The second was purchased in 1859. Their composition is as follows:

	1858.	1859.
Gypsum or Plaster of Paris . .	25.30	39.31
Soluble Phosphate of Lime . . .	2.53	2.95
Free Phosphoric Acid . . .	6.86	4.45
Lime otherwise combined . . .	2.07	
Phosphoric Acid com'd with lime and magnesia		2.23
Sand	11.04	14.30
Animal Charcoal and organic matter, (Containing some ammonia,) .	22.30	12.32
Magnesia, Iron, water &c., not determined	4.66	15.95

The useful matters may be summed up as follows, and I have also calculated their money value in the manner adopted by Professor Johnson.

THAT OF 1858.

	Per ct.	Price.	Am't.
Gypsum	25.30	⅓ ct.	$0.08½
Phosphoric Acid Insoluble .	11.65	4½ct.	0.52½
" " Soluble .	8.40	12½ct	1.05
Value of 100 lbs. of the fertilizer .			$1.66

THAT OF 1859.

Gypsum	39.31	⅓ct.	$0.13
Phosphoric Acid insoluble . .	7.06	4½ct.	0.31¾
" " Soluble . .	6.27	12½ct.	0.78½

The value of 100 lbs. being multiplied by 20, gives the value of a ton of each.

Thus, that of 1858 is worth	$33.20
1859 " " . . .	24.60
Difference against the latter . . .	$9.60

The proportion of Ammonia was two small in either to be worthy of notice.

Comment is unnecessary. I have given the chemical constitution and its money value, so that the farmer may really know what he is buying.

The result of all this shows a great falling off in the value of three manures, which have been much used in Maryland, whilst in two others (Coe's & Rhode's) the quality has been generally maintained.

What quantities of these inferior articles have been sold to our farmers because of their original reputation cannot be ascertained, but it would seem that means should be taken to arrest such frauds.

It is felony to obtain money or goods under false pretences, and people are punished criminally for such acts. Is it not equally criminal in morals, if not in law, to publish certificates of the existence of certain proportions of valuable matter in a manure, and yet sell a material containing perhaps one-third or one-half the amounts stated in such certificates?

After consultation with many farmers and planters, and seriously reflecting upon this subject, I am fully satisfied that if a proper sum be allowed me for such assistance as will permit a comprehensive system of analysis to be executed, the evil will be very soon corrected.

The conscientious maker or dealer will of course furnish fair samples; but as there might be some who would act otherwise, I would propose to take such means as would

insure samples of the articles actually received by the farmer.

Such a number of each kind used in this state should be analyzed from time to time as will keep the public informed of their composition and value.

The law might require them to be reported monthly or quarterly to the Governor or other officer, and published in one or more papers in each county, as in the case of the laws.

The effect of these measures would not fail to afford ample protection to the farmer against both fraud and ignorance, and whilst benefiting the honest dealers would very soon drive all others out of the trade."

First Report of Philip T. Tyson, State Agricultural Chemist to the House of Delegates of Maryland, January 1860 pp. 101–102, pp. 130–132.

I have selected the testimony of Professor Tyson because he is the appointed chemist of a State from which we receive a large portion of our Guanos and manufactured manures.

It should be remembered by the Planters of Georgia, that in most instances, the manufacturers of these compounds are residents of distant States, and that the venders, in our midst are also in many instances natives of distant States—birds of passage, who come merely to make a fortune and then to migrate to colder regions. It results from this, that whatever losses of money occur in the purchase of fertilizers, they are in almost every case total losses to the State of Georgia, for the money does not simply change hands amongst her own citizens, but is carried out of the State.

The only method of protecting the planters, is that recommended to the House of Delegates of Maryland by Mr. Tyson.

A law should be passed compelling the venders of fertilizers to throw open their entire stock to the inspection and examination of competent chemists. No honest man will object to this test. Dishonest men will always endeavor

to defeat the execution of the law. Every attempt to elude a fair examination, should of itself be sufficient warning to the Planters of Georgia that there is fraud.

We will now institute a careful and impartial comparison between the commercial fertilizers, and Marls and Shell Limestone of Georgia.

In this comparison, it would be manifestly unjust to compare pound with pound in the commercial and native fertilizers; to render the comparison just and equal, we must compare the amounts necessary for each acre of land.

The following table presents the composition of the Shell Limestone and Marls of Georgia in tons and bushels, and in comparing it with the preceding tables of the chemical constitution of the commercial fertilizers, we should compare bushels with pounds.

TABLE 18—Showing the Chemical Composition of the Shell Limestone and Marls of Georgia in Tons and Bushels.

	Carb. of Lime	Lime	Phosp'te of Lime	Phosphoric Acid	Carb. Magnesia	Sulphate Lime	Sulphuric Acid	Chlorides	Alumina & Oxide of Iron	Insol. Silicates	Silicious Sand	Water as Moist.	Organic Matter
Green Marl, 100 parts contain	43.435	24.282	3.649	1.677	0.270	trace	trace	0.014	7.196	31.941	8.055	5.714	......
One Ton of 2,000 pounds contain	868.700	485.64	72.980	33.540	5.400	......	......	0.280	143.92	638.82	161.100	114.28	......
One Hundred bushels contain	4343.	2428.	364.9	167.7	27	......	......	1.4	719.	3194.	805.	571.	......
200 bushels contain	8686.	4856.	729.8	335.4	54.	......	......	2.8	1439.	6388.	1601.	1143.	......
300 bushels contain	13029.	7284.	1094.7	503.4	81.	......	......	4.2	2158.	9582.	2415.	1714.	......
400 bushels contain	17372.	9712.	1459.6	690.8	108.	......	......	5.6	2878.	12776.	3222.	2285.	......
500 bushels contain	17715.	12141.	1820.5	838.5	135.	......	......	7.0	3598.	15970.	4027.	2857.	......
1,000 bushels contain	43430.	24280	3649.	1677.	270.	......	......	14.	7196.	31941.	8050.	5714.	......
Yellow Marl, 100 parts contain	43.023	24.99	6.465	2.971	0.841	0.002	0.002	0.01	0.265	40.178	5.62	3.1	......
One Ton of 2,000 parts contain	860.46	499.86	129.30	59.42	16.82	0.04	0.02	0.2	5.3	803.56	112.4	62.0	......
100 bushels contain	4302.	2499.	646.5	297.1	84.	0.2	0.1	1.0	26.	4017.	562.	310.	......
200 " "	8604.	4998.	1293.0	594.2	168.	0.4	0.2	2.0	53.	8035.	1124.	620.	......
300 " "	12906.	7497.	1939.5	891.3	252.	0.6	0.3	3.0	79.	12053.	1686.	930.	......
400 " "	17208.	9997.	2586.0	1188.4	336.	0.8	0.4	4.0	105.	16071.	2248.	1240.	......
500 " "	20510.	12496.	3232.0	1485.	420.	1.0	0.5	5.0	132.	2248.	2810.	1550.	......
1000 " "	43020.	24993.	6465.0	2971.	841.	2.0	1.0	10.0	265.	1240.	5620.	3100.	......
White Shell Limestone 100 parts contain	87.742	49.192	0.933	0.427	0.770	0.103	......	0.005	0.266	4.552	4.062	0.117	......
One Ton of 2,000 pounds contain	1755.	983.	18.66	854.	3.4	2.06	......	0.1	5.32	91.	81.	2.3	......
One Hundred bushels contain	8774.	4919.	93.3	42.7	77.	10.3	......	0.5	26.6	455.	406.	11.7	......
200 " "	17548.	9838.	186.6	85.4	154.	20.6	......	1.0	53.2	910.	812.	23.4	......
300 " "	25322.	14757.	279.9	128.1	231.	30.9	......	1.5	79.8	1365.	1218.	35.1	......
400 " "	35096.	19676.	373.2	170.8	308.	41.2	......	2.0	106.4	1820.	1624.	46.8	......
500 " "	43870.	24596.	465.5	213.5	385.	51.5	......	2.5	133.0	2276.	2031.	58.5	......
1000 " "	87742.	49192.	933.0	427.	770.	103.	......	5.0	266.	4552.	4062.	117.0	......

TABLE 18—Continued.

	Carbonate Lime.	Lime.	Phosphate Lime	Phosphoric Acid in Phosphate of Lime	Carb. Magnesia.	Sulphate Lime.	Sulphuric Acid.	Chlorides.	Alumina & Oxide of Iron.	Insol. Silicates.	Silicious Sand.	Water as Moist.	Organic Matter.
White Shell Marl, 100 parts contain	71.932	40.282	0.426	0.196	0.028	0.001	......	0.005	1.248	19.062	5.466	0.842	......
One Ton of 2,000 pounds contain	1438.	633.	8.52	3.920	0.56	0.02	......	0.10	24.9	381.	119.	16 8	......
100 bushels contain	7932.	4028.	42.6	19.6	2.8	0.1	......	0.5	124.	1906.	546.	84.	......
200 " "	15864.	8056.	85.2	39.2	5.6	0.2	......	1.0	249.	3812.	1093.	168.	......
300 " "	23796.	1208.	127.8	58.8	8.4	0.3	......	1.5	373.	5718.	1639.	252.	
400 " "	31728.	16112.	170.4	78.4	11.2	0.4	......	2.0	498.	7624.	2186.	336.	......
500 " "	39660.	20140.	213.0	98.0	14.0	0.5	......	2.5	624.	9530.	2733.	420.	......
1000 " "	79320.	40.280	426.0	196.0	28.0	1.0	......	1240.	1240.	1240.	5460.	1680.	......
Bluish Black Marl 100 parts contain	9.739.	5.454	0.615	0.283	0.030	......	......	0.120	1.140	32.190	47.118	6.628	1.398
One Ton 2,000 pounds contain	194.	109.80	12.2	5.66	0.6	......	......	2.4	22.8	643.	943.	133.5	27.960
100 bushels contain	973.9	545.	61.5	28.	3.	......	......	12.	114.	3219.	4717.	662.	139.8
200 " "	1947.8	1090.	123.0	56.	6.	......	......	24.	228.	6438.	9434.	1325.	279.6
300 " "	2921.	1635.	184.5	88.	9.	......	......	36.	34.2	9657.	13151.	1988.	419.4
400 " "	3895.	2180.	246.0	112.	12.	......	......	48.	456.	12876.	18868.	2651.	559.2
500 " "	4867.	2725.	307.[illegible]	140.	15.	......	......	60.	570.	16077.	23585.	3314.	699.0
1000 " "	9739.	5450.	615.0	280.	30.	......	......	120.	1140.	32190.	47170.	6628.	1398.
Swamp Deposit, 100 pounds contain	2.083	1.167	0.292	0.134	0.009	......	......	......	1.329	28.4	......	64.7	2.912
One Ton 2,000 pounds contain	41.66	23.34	5.84	2.68	0.180	......	......	......	26.58	568.	......	1294.	58.24
100 bushels contain	208.3	116.7	29.2	13.4	0.9	......	......	......	132.	2840.	......	6471.	291.
200 " "	416·6	233.4	58.4	26.8	1.8	......	......	......	265.	5681.	......	12942.	582.
300 " "	624.9	350.1	87.6	40.2	2.7	......	......	......	398.	8522.	......	19414.	873.
400 " "	833.2	468.	116.8	53.6	3.6	......	......	......	531.	11363.	......	25885.	1164.
500 " "	1041.	583.	146.0	68.0	4.5	......	......	......	664.	14204.	......	32357.	1456.
1000 " "	2083.	1167.	292.0	134.	9.	......	......	......	1329.	28409.	......	64714.	2912.

TABLE 18—Continued.

	Carbonate Lime.	Lime	Phosphate Lime	Phosphoric Acid in Phosphate of Lime......	Carb. Magnesia.	Sulphate of Lime	Sulphuric Acid.	Chlorides.......	Alumina and Oxide of Iron ...	Insol. Silicates.	Silicious Sand..	Water as Moistur	Organic Matter.
Swamp Deposit, Dry 100 parts contain..........	6.808	3.813	0.822	0.378	0.29	trace	......	......	3.766	80.20	......	......	8.221
One Ton of 2000 pounds contain..........	136.16	76.26	16.44	7.56	0.58	......	......	......	75.	1604.	......	......	164.42
100 bushels contain..........	680.8	381.	82.2	37.8	2.9	......	......	......	376.	8021.	......	......	822.
200 " "	1362.6	762.	164.4	75.	5.	......	......	......	753.	16042.	......	......	1644.
300 " "	2042.4	1043.	246.6	113.	8.	......	......	......	1128.	24063.	......	......	2466.
400 " "	27232.	1524.	328.8	151.	11.	......	......	......	1504.	42084.	......	......	3288.
500 " "	3404.	1805.	410.0	189.	14.	......	......	......	1880.	40105.	......	......	4110.
1000 " "	6808.	3810.	822.	378.	29.	......	......	......	3766.	80211.	......	......	8221.
Reddish Brown Marl, 100 parts contain..........	42.389	23.738	0.218	0.1	0.157	trace	trace	trace	2.265	23.846	22.9	8.102	......
One Ton 2,000 pounds contain..........	847.78	474.	4.36	2.0	3.14	......	......	......	45.3	466.9	458.	162.	......
100 bushels contain..........	4238.	23.73	21.8	10.0	15.7	......	......	......	226.	2334.	2290.	810.	......
200 " "	8476.	4647.	43.6	20.	31.4	......	......	......	453.	4669.	4580.	1620.	......
300 " "	12704.	7121.	64.4	30.	47.1	......	......	......	679.	7003.	6870.	2430.	......
400 " "	16952.	9485.	87.2	40.	62.	......	......	......	906.	9338.	9160.	3240.	......
500 " "	21190.	11869.	109.0	50.	78.	......	......	......	1132.	11672.	11450.	4050.	......
1000 " "	42380.	23730.	218.0	100.	157.	......	......	......	2265.	23340.	22900.	8100.	......
Reddish Brown Marl, natural state, 100 parts cont'd	15.473	8.665	0.349	0.161	trace	trace	trace	0.086	2.005	42.662	16.942	21.85	......
One Ton 2,000 pounds contain..........	30.946	173.3	6.98	3.23	......	......	......	1.726	40.1	853.	338.	427.1	......
100 bushels contain..........	1547.	866.	34.9	16.1	......	......	......	8.0	200.	4266.	1694.	2185.	......
200 " "	3094.	1733.	69.8	32.2	......	......	......	17.3	401.	8532.	3388.	43.1.	......
300 " "	4541.	2599.	104.7	48.3	......	......	......	25.8	601.	12798.	5082.	6556.	......
400 " "	5188.	3466.	135.6	64.4	......	......	......	34.4	802.	17064.	6776.	8742.	......
500 " "	7735.	4332.	174.5	70.5	......	......	......	43.0	1002.	21330.	8270.	10928.	......
1000 " "	15470.	8660.	349.	161.	......	......	......	86.	2005.	42660.	16940.	21850.	......
Reddish Brown Marl, 100 parts contain..........	19.799	11.087	0.446	0.206	......	......	......	0.107	2.865	54.594	21.68.	......	......
One Ton of 2000 pounds contain..........	395.98	221.7	8.92	4.12	......	......	......	2.140	5.134	1091.	633.	......	......
100 bushels contain..........	1979.9	1108.	44.6	20.6	......	......	......	10.7	256.	5459.	2168.	......	......

TABLE 18—Continued.

	Carbonate Lime.	Lime.	Phosp'te of Lime	Phosphoric Acid in Phosphate of Lime	Carb. Magnesia.	Sulphate of Lime	Sulphuric Acid..	Chlorides.	Alumina and Oxide of Iron...	Insol. Silicates.	Silicous Sand...	Water as Moist..
Reddish Brown Marl, 200 bushels contain	3959.	2217.	89.2	41.2	......	......	......	21.4	513.	10918.	4336.	......
300 " "	5939.	3326.	133.8	61.8	......	......	......	32.1	719.	16378.	6504.	......
400 " "	7919.	4434.	178.4	82.4	......	......	......	42.8	102.6	21837.	8672.	......
500 " "	9899.	5543.	223.0	102.0	......	......	......	53.5	1282.	26297.	10850.	......
1000 " "	19799.	11087.	445.	206.	......	......	......	107.	2575.	54594.	21680.	......
White Shell Limestone, 100 parts contain	80.076	44.843	1.181	0.544	0.009	0.004	......	0.009	0.694	4.018	13.08	0.681
One Ton of 2,000 pounds contain	1615.2	896.8	23.62	10.88	0.180	0.080	......	0.180	13.88	80.36	261.6	13.62
100 bushels contain	8007.	4484.	118.1	54.4	0.9	0.4	......	0.9	69.	401.8	1308.	68
200 " "	16015.	8968.	236.2	108.8	1.8	0.8	......	1.8	138.	803.	2616.	136.
300 " "	24022.	13452.	354.3	173.2	2.7	1.2	......	2.7	218.	1205.	3924.	204.
400 " "	32030.	18936.	472.4	217.6	3.6	1.6	......	3.6	277.	1607.	5232.	272.
500 " "	40038.	22421.	590.5	272.0	4.5	2.0	......	4.5	347.	2009.	6540.	340.
1000 " "	80070.	44843.	1181.	544.	9.	4.	......	9.	694.	4018.	13081.	681.
White Shell Limestone 100 parts contain	85.285	47.76	0.25	0.115	2.22	trace	tracc	0.019	0.876	0.393	10.708	0.214
One Ton 2000 pounds contain	1705.70	955.	5.0	2.3	44.4	......	......	0.38	17.52	7.86	214.16	4.28
100 bushels contain	8528.	4776.	25.	11.5	222.	......	......	1.9	87.	39.3	1070.	21.
200 " "	17156.	9552.	50.	23.	444.	......	......	3.8	175.	78.6	2141.	42.
300 " "	25584.	14328.	75.	34.5	666.	......	......	5.7	262.	87.9	3212.	64.
400 " "	34112.	18004.	100.	46.	888.	......	......	7.6	350.	157.2	4283.	85.
500 " "	42640.	23880.	125.	57.4	1110.	......	......	9.5	438.	196.5	5354.	107.
1000 " "	85280.	47760.	250.	115.	2220.	......	......	19.	876.	393.	10708.	214.
Shell Limestone 100 parts contain	92.216	51.86	0.628	0.298	trace	0.300	trace	0.015	1.17	4.5	0.933	0.3
One Ton of 2,000 peunds contain	1844.32	1030.	12.56	5.96	......	6.00	......	0.300	23.4	90.	18.6	6.
100 bushels contain	9221.	5186.	62.8	29.8	......	30.	......	1.500	117.	450.	93.	30.
200 " "	18442.	10372.	125.6	59.6	......	60.	......	3.0	234.	900.	186.	60.
300 " "	27663.	15558.	188.4	89.4	......	90.	......	4.5	351.	1350.	279.	90.
400 " "	36884.	20074.	251.2	119.2	......	120.	......	6.0	468.	1800.	373.	120.
500 " "	46105.	25930.	514.0	149.0	......	150.	......	9.5	585.	22[illegible]0.	466.	150.
1000 " "	92210.	51860.	623.0	298.	......	300.	......	15.	1170.	4500.	930.	300.

The careful comparison of the individual elements of the commercial fertilizers with the individual elements of the Tertiary Lime formation of Georgia establishes the following results and conclusions.

1. 100 bushels of the Green Marl contains four times more Phosphoric Acid, and as a necessary consequênce four times more phosphate of lime than one hundred pounds of Phosphatic, Amonia Phosphatic, and Peruvian Guanos, or of any other commercial fertilizer.

2. 100 bushels of the Yellow Marl contains eight times more Phosphate of Lime than one hundred pounds of any known Guano or manufactured manure.

It would be perfectly safe to apply one hundred pounds of these Marls to any land in Georgia, and if the lands be newly cleared and rich in organic matters we might double and treble the amount.

The experiments of Senator Hammond and others have rendered it at least probable that the lands of South Carolina and Georgia will not bear as heavy applications of Marl as the lands of England, Virginia and Maryland, and hence I would not until Careful experiments have determined the exact amount of Marl which is sufficient for our lands in Georgia, recommend the application of this Green and Yellow Marl upon sandy cultivated lands, in larger amounts than 200 bushels.

When I have completed the chemical analysis of the soils of Georgia, I hope to be able to speak with more precision.

It is evident, nevertheless, that even with this small amount to each acre, the Marls of Georgia will furnish far more phosphoric Acid and Phosphate of lime than the expensive commercial fertilizers which we have shown to be also liable to adulteration.

In making this comparison we have impartially compared these Marls with the very best fertilizers in the market.

3. 100 bushels of the White shell Limestones Nos. 3, 11 and 13 contain a greater amount of Phosphate of lime than exists in 100 pounds of the great majority of the Guanos and manufactured compounds.

4. 100 bushels of the Marls and Shell Limestone which contain the least Phosphate of Lime, contain fully as much as the most inferior Guanos and manufactured manures.

5. It would be safe to apply 1000 bushels of the Bluish Calcareous Clay, which we have for convenience called a Bluish Black Marl, although it contains less Carbonate of Lime than usually exists in Marls, to each acre of land. In this amount we would obtain 610 pounds of Phosphate of Lime, an amount at least twice as great as that contained in a most liberal application of the best Guanos and commercial manures. Hence with truth I affirmed that this bluish black Marl would be a most valuable fertilizing agent to the surrounding exhausted sandy lands. The clay itself which it contains will prove a valuable addition to the lands which need clay. It is evident however that this calcoreous earth would not bear a long transportation either on the farm or on the Railroad, for it contains too much clay.

6. It would be safe to apply 1000 bushels of the Black swamp deposit, No. 7, (which we have called swamp muck for this was the name by which it was designated by the surrounding inhabitants) to each acre of land. In this amount we would apply as much Phosphate of Lime as is contained in 1000 pounds of the very best Phosphatic Guanos, and in addition to this we will apply together with the Phosphate 8221 pounds of Organic matters, and 6808 pounds of Carbonate of Lime. Although the organic matters are not as soluble, or as valuable sources of Ammonia, as the organic matters, of Phosphatic and Ammonia Phosphatic Guanos, still it is well known to every chemist, that lime promotes the disintegration of the most stable and insoluble compounds, hence the deposits of swamps and peat bogs which are comparatively inert, are readily decomposed and prepared for vegetation by the action of Carbonate of Lime.

The value of this black swamp deposit would on this very account be increased by mixing it intimately with one

quarter of its weight of pounded Shell Limestone or one twentieth of Lime.

This would be easily accomplished, for the surrounding hills are composed in great measure of Shell Limestone. It should be borne in mind that a less quantity of the mixture should be added to the land.

The remarks which we made with reference to the Bluish Black Marl, or Calcareous earth, apply also to this Black Swamp deposit.

7. 200 bushels of the Reddish Brown Marls would contain as much Phosphate of lime as is found in the Guanos and manipulated compounds of medium quality.

To render these facts still more plain we have drawn up the following table.

Table 19.—Showing the comparative amounts of Phosphate of Lime in corresponding Bushels and pounds of Georgia Marl and Shell Limestone and commercial fertilizers:

	100 bushels	200 bushels	300 bushels	1000 bushels		100 pounds	200 pounds	300 pounds	1000 pounds		100 pounds	200 pounds	300 pounds	1000 pounds
	lbs	lbs	lbs	lbs		lbs	lbs	lbs	lbs		lbs	lbs	lbs	lbs.
No. 1.—Green Marl	364.	729.	1094.	7298.	American Guano loose	50.	100.	150.	1003.	Saldanha Bay Guano	58.	117	176.	1175.
No. 2.—Yellow Marl	664.	1293	1939.	12930.	American Guano lump	59.	118.	177.	1180.	do do do	60.	120	180.	1219.
No. 3.—White Shell Limestone	93.3	186.6	279.9	1866.	Brown Mexican Guano	35.	70.	106.	707.	do do do	54.	109.	164.	1096.
No. 4.—White Shell Marl	42.	85.	127.	852.	do do do	36.	72.	108.	722.	Peruvian Guano	25.	50.	75.	500.
No. 5.—Bluish Black Marl	61.	123.	184.	1230.	do do do	52.	105.	158.	1054.	do do	41.	82.	123.	820.
No. 6.—Swamp Deposit	29.	58.	87.	584.	do do do	67.	135.	202.	1353.	do do	30.	60	90.	600.
No. 7.—Dry Swamp Deposit	82.	164.	246.	1644.	African Guano	38.	76.	114.	762.	do do	31.	62	93.	620
No. 8.—Reddish Brown Marl	21.	43.	64.	436.	Brown African Guano	40.	80.	120.	804.	do do	21.	42.	63.	420.
No. 9.—Reddish Brown Marl	34.	69.	104.	698.	Navis Island Guano	16.	33.	49.	330.	do do	31.	62.	93.	620.
No. 10—Dry Reddish Brown Marl.	44.	89.	133.	892.	White Mexican	81.	162.	243.	1620.	do do	19.	38.	57	380.
No. 11—White Shell Limestone	118.	236.	354.	2362.	Columbian Guano	87.	175.	263.	1759.	Grass Manure	31.	62.	93.	620.
No. 12.—White Shell Limestone	25.	50.	75.	500.	Sombrero Guano	75.	150.	225.	1500.	Rhodes Superphosphate	46.	92	138.	920.
No. 3.—White Shell Limestone.	62.	125.	188.	1256.	do do	79.	159.	239.	1594.	do do	44.	88.	132.	880.
					do do	77.	155.	233.	1555.					
					Navassa Guano	68.	136.	205.	1369.					
					ElMontana Guano	60.	120.	180.	1203.					
					California Guano	26.	52	78.	520.					
					do do	38.	76.	114.	760					
					do do	23.	46	69.	460.					
					Saldanha Bay Guano	56.	113.	170.	1130.					

8. In the preceding calculations we have left entirely out of view the important fact that these Marls and Shell Limestone contain Carbonate of Lime, which is considered by the most experienced agriculturists to play even a more important part in the economy of vegetation and in the chemical changes of the soil, than the Phosphate of lime.

Thus in 100 bushels of Green Marl we would have 4383 pounds of Carbonate of Lime, in the Yellow Marl, 4302 pounds, in the other Marls from 200 to 4238 pounds and in the Shell-Limestone from 7932 to 9221 pounds of Carbonate of Lime

CONCLUSIONS.

1. The Tertiary Lime-formation of Georgia is capable of supplying the entire State with the Phosphates and Carbonates of Lime for unnumbered ages.

2. If the planters of Georgia employ the natural resources of their State, they will have no need whatever to purchase a single pound of Phosphate of Lime in whatever form it be present in the market.

3. The application of Phosphatic Guanos and superphosphates to soils to which the Marls and Shell-Limestone of Georgia have been applied, would be wholly unnecessary and would produce no special beneficial effect. The truth of this assertion has been demonstrated in those states and countries in which Marls rich in the phosphates have been applied to the soil.

4. In as much as Peruvian Guano contains a large proportion af Ammonia and of organic compounds, capable of generating Ammonia during decomposition in the soil, it is far more suitable as an application to Marled lands than the Phosphate of Lime and Phosphatic Guanos. The high price of Peruvian Guano, however will be a serious obstacle to its extensive use; and we shall endeavor to demonstrate before we leave this subject, that the planters of Georgia do not need Peruvian Guano or any other commercial fertilizer as sources of Ammonia and of the inorganic compounds necessary to the developement of Plants, and the improvement of the soil.

We will in the next place consider the relations to soils, plants and animals, and the effects and mode of application of the Marls and Shell-Limestone of Georgia. It will be impossible upon the present occasion to do more than present general and well established results and conclusions.

The whole subject will be fully and carefully discussed in the large report which we expect to present to the cotton planters convention, when the Agricultural Survey of Georgia is completed.

CHAPTER VI.

RELATIONS

OF THE

IRLS AND SHELL LIMESTONE OF GEORGIA,

To Soils.

CHAPTER III.

Relations of Marls and Shell Limestone to Soils.

That lime is indispensable to the fertility of the soil, has been demonstrated by the universal experience of agriculturists, and by the important results attained by the application of calcareous manures to lands of every geological formation, and of every quality, and by the known chemical and physical effects of lime and its compounds upon the constituents of soils and of animal and vegetable manures.

The full discussion of the relations of lime to soils and to plants and animals would fill a volume and must necessarily be deferred for the present. We hope, however to present such an array of facts and results as will lead to intelligent and efficient action.

The following well established facts will serve the purpose of demonstrating the proposition that lime is indispensable to the fertility of the soil.

Soils devoid of lime, no matter what other salts they may contain are in all countries barren.

The addition of calcareous manures to soils deficient in lime changes both their physical and chemical characters, and if the other salts necessary for vegetation, be either present as constituents of the soil, or be added in the form of manure, renders them fertile.

Chemical analysis has shown that lime and its compounds are present in all fertile soils.

We would hope that those who deny that lime is necessarily present in all fertile soils constitute but a small class amongst practical agriculturists.

To place this proposition in a clear light and to demonstrate it beyond all contradiction and at the same time to develope important facts to guide the planter in the application of lime to various soils, we have drawn up the following tables which embody reliable results obtained in Europe and this country.

In every case the entire series have been selected so that the examples brought forward to prove that lime is a constituent of all fertile soils are free from every objection.

TABLE 20.—ANALYSIS OF THE SOILS OF DIFFERENT LOCALITIES IN EUROPE.—KANE.*

Each soil dried at 100° CONSTITUENTS.	No. 1. Heerstert, near Courtray......	No. 2. Escamaffles, best flax land in Courtray	No. 3. Hamme Zog best flax land in Antwerp	No. 4. A district yielding only thin crops of coarse flax.	No. 5. A good flax district in Holland ..	No. 6. Crowle in Lincolnshire, so-called "Warp"......
Potassa..............	0 160	0.123	0.068	0.151	0 583	0.534
Soda..................	0.298	0.146	0.110	0.206	0 306	0.083
Sesquioxide of iron...	3.298	1.663	1.202	1.543	6.047	4.510
Sesquioxide of manganese..............	trace.	trace.	trace.		trace.	decided trace
Alumina...............	2 102	1.383	1 125	0.988	5 626	3.065
Lime..................	0 357	0.227	0.481	0.366	3 043	5.538
Magnesia..............	0 202	0.153	0.140	0.142	0 105	0.052
Sulphuric Acid........	0 025	0 017	0 013	0.026	0 023	0.113
Phosphoric Acid.......	0.121	0.152	0 064	0.193	0.159	0.222
Chloride of Sodium....	0 017	0 030	0.067	0.009	0 023	0.067
Clay..................	14.920	9.280	5.760	4.400	17 080	
Sand..................	75.080	84.065	86.797	88.385	60.947	80.702
Organic matter, remainder of the moisture................	3.123	2.361	4.209	3.672	5.841	5.328
Loss..................	0.297	0.400	9 025		0.217	
	100.000	100.000	100.000	100.081	100.000	100.204

* Phil. Mag. [3], xxxi, 36 and 105. Liebig and Kopps Annual Report in Chemistry, &c., vol. 2, p. 328.

TABLE 21.—ANALYSES OF SOILS OF EUROPE*

	Number	1			2			3			4		
		Weidenbusch.	Varrentrapp.	Steinberg.	Rammelsberg.	Hagen.	Nitzsch.	Hagen.	Nitzsch.	Rammelsberg.	Bodeker.	Marchand	Trommer.
		Soil of Eldena.			Soil of Wollup.			Soil of Beesdau.			Soil of Neuensund.		
Organic substance.	Carbon	0.53	1.00	1.00	1.810	3.197	2.570	1.438	1.486	0.811	1.243	1.108	1.137
	Nitrogen	0.11	0.12	0.11	0.200	0.298	0.271	0.137	0.249	0.108	0.147	0.103	0.010
	Hydrogen	0.24	1.25	0.21	7.120	0.697	0.692	0.289	0.423	2.518	0.173	3.329	2.383
	Oxygen	....		1.52		4.368	5.550	2.102	3.399		2.544		
Soluble in dilute hydrochloric acid.	Sulphur	....	....	....	....	....	....	....	....	....	0.007	....	0.044
	Chlorine	0.20	0.01	0.01	0.003	trace	0.023	trace	0.121	0.003	0.005	0.032	0.005
	Carbonic acid	0.40	0.10	....	0.063	....	....	0.036	....	trace	0.372	0.880	0.263
	Sulphuric acid	0.08	....	0.02	0.002	....	0.099	....	....	0.004	0.050	0.038	0.241
	Phosphoric acid	0.06	0.17	0.40	0.009	0.169	0.832	0.042	0.046	0.007	0.103	0.010	0.121
	Silicic acid	0.85	....	0.24	....	2.375	....	....	....	....	1.881	0.291	....
	Sesquioxide of iron	0.16	0.93	1.28	2.229	3.765	5.711	0.949	1.361	1.149	0.130	2.447	1.472
	Sesquiox. of manganese	0.94	....	0.37	....	....		....			0.145	0.011	0.479
	Alumina	2.78	0.57	0.05	0.478	5.031	2.324	1.322	1.749	0.369	0.649	2.198	1.964
	Lime	0.39	0.12	0.25	0.595	0.617	0.591	0.334	0.039	0.325	0.841	0.329	0.577
	Magnesia	0.17	....	2.28	0.085	0.295	0.428	0.095	0.355	0.057	0.143	0.341	0.198
	Potassa	0.88	0.13	....	0.027	0.337	0.176	0.419	0.490	0.060	0.047	0.247	0.192
	Soda	0.27	0.05	....	0.006	0.116	0.405	0.038	0.022	trace		0.039	0.050
	Chloride of sodium	....	....	....	....	....	....	....	....	....	....	....	....
Insoluble in dilute hydrochloric acid.	Silicic acid	86.25	87.29	88.63	63.642	72.400	71.474	83.600	86.083	87.581	79.587	83.935	82.954
	Sesquioxide of iron	1.78	1.15	0.71	5.697	....	4.420	trace	0.874	1.092	0.690	0.979	0.783
	Sesquiox. of manganese	....	....		....	....		....			....	trace	0.110
	Alumina	3.39	3.92	4.71	10.948	4.309	3.055	6.892	2.230	2.671	4.526	2.092	4.845
	Lime	....	0.63	0.12	0.940	0.272	0.480	0.468	....	0.390	1.043	0.285	0.151
	Magnesia	....	0.28		2.234	0.246	....	....	0.105	1.078	0.526	0.178	0.204
	Potassa	0.55	1.93		2.645	1.434	0.117	3.406	....	0.732	3.888	1.042	1.051
	Soda	0.40	0.33		1.267	0.722	0.395	....	0.654	1.045	2.259	0.507	0.766
	Total	98.95	99.98	99.908	100 000	100.643*	99.618	101.567	99.686*	100.000	100.000	100.000 0.061NH^3 and 0.044NO_5	100.000

*Besides carbonate of ammonia.

*Annual report of the Progress of Chemistry and the Allied Sciences, by Justus Liebig and H. Kopp, vol. iii, 1849, p. 465.

TABLE 22.—ANALYSES OF SOILS OF EUROPE.*

	Number	5			6			7			8		
		Bodeker.	Marchand	Trommer.	Schulze	Schulze	Birner	Schulze	Schulze	Birner.	Genth.	Heintz.	Krocker
		Soil of Cartlow.			Soil of Burg-Bornheim.			Soil of Laasan.			Soil of Turwe.		
Organic substance.	Carbon	0.935	0.979	0.886	1.109	1.147	0.900*	1.285	1.325	1.004*	1.760	1.84	1.290
	Nitrogen	0.076	0.106	0.005	0.102	0.114	1.409†	0.112	0.113	1.812†	0.140	0.18	0.178
	Hydrogen	0.119	1.915 (Hydrogen and Oxygen)	1.749	2.062	1.989	....	2.252	2.165	....	3.615	0.52	2.187 (Hydrogen and Oxygen)
	Oxygen	1.962										2.45	
	Sulphur	0.058	....	0.002	0.008	....	....	0.006	....	....	....	0.009	....
Soluble in dilute hydrochloric acid.	Chlorine	0.014	0.003	0.002	0.002	0.003	0.027	0.005	0.004	0.017	0.010	....	0.005
	Carbonic acid	0.033	0.086	....	....	....	0.098	....	....	0.101	0.077	1.69	2.328
	Sulphuric acid	0.012	0.030	0.030	0.030	0.035	0.023	0.040	0.040	0.031	0.040	0.03	0.022
	Phosphoric acid	0.006	0.007	0.009	0.084	0.072	0.008	0.100	0.107	0.012	0.057	0.20	0.014
	Silicic acid	0.027	0.450	....	0.010	0.018	....	0.014	0.008	....	0.701	...	0.196
	Sesquioxide of iron	1.169	1.210	1.268	2.520	1.824	2.816	1.652	1.530	1.552	0.459	0.68	0.794
	Sesquiox. of manganese	0.022	0.001	0.181	0.104	0.092	trace	0.124	0.112	trace	trace	....	0.139‡
	Alumina	0.232	1.488	1.439	1.512	1.602	1.228	1.576	1.690	1.184	0.810	1.12	1.040
	Lime	0.391	0.099	0.235	0.212	0.298	0.232	0.144	0.166	0.273	2.062	2.19	3.169
	Magnesia	0.101	0.047	0.097	0.178	0.216	0.299	0.136	0.148	0.217	0.641	0.58	0.043
	Potassa	0.132	0.203	0.160	0.122	0.109	0.159	0.104	0.122	0.121	0.102	0.56	0.113
	Soda	0.271	0.090	0.013	0.030	0.045	0.079	0.058	0.025	0.095	0.047	0.18	0.006
	Chloride of sodinm	....	....	....	....	....	....	....	....	....	....	....	....
Insoluble in dilute hydrochloric acid.	Silicic acid	82.488	85.997	87.461	80.280	79.704	81.988	81.520	81.535	82.908	80.200	83.52	85.810
	Sesquioxide of iron	0.157	1.739	0.324	1.560	1.379	0.988	1.400	8.045 (Sesquioxide of iron and Sesquiox. of manganese)	0.763	1.150	0.56	0.490
	Sesquiox. of manganese	0.110	trace	0.006	....	....	trace	....		trace	0.240	....	....
	Alumina	0.978	3.319	4.380	6.280	6.481	6.692	6.680	....	6.145	3.250	1.67	1.403
	Lime	0.330	0.447	0.192	6.480	0.689	1.805	0.360	0.363	1.201	0.250	0.48	0.222
	Magnesia	6.987	0.361	0.108	0.520	0.586	0.415	0.240	0.155	0.473	0.160	1.10	....
	Potassa	0.792	1.104	0.666	1.440	1.325	0.279	1.040	1.334	0.217	1.010	0.58	0.088
	Soda	0.598	0.083	0.787	0.880	0.883	0.023	0.320	0.358	0.018	1.217	0.87	0.276
Total		100.000 0.192NH^3 and 0.044NO_5.	100.000	100.000	99.525	98.561	98.468	99.168	99.345	98.144	97.908	100.459	99.808

*Humic acid. †Humin. ‡CuO.

*Annual report of the Progress of Chemistry and the Allied Sciences, by Justus Liebig and H. Kopp, vol. iii, 1849, p. 465.

TABLE 23.—ANALYSES OF SOILS OF EUROPE.*

Number		9			10			11			12		
		Rose.	Kucke.	Krocker.	Rammelsberg.	Kucke	Krocker	Rammelsberg.	Heintz.	Debus.	Rammelsberg.	Krocker.	Knop.
		Soil of Burg-Wegeleben.			Soil of Frankenfelde.			Soil of Jurgaitschen.			Soil of Neuhof.		
Organic substance.	Carbon	2.360	0.018	2.850	0.750	....	0.759	1.03	2.92	3.010	0.48	1.534	1.718
	Nitrogen	0.432	....	0.272	0.079	2.640	0.093	0.24	0.35	0.280	0.13	0.154	0.011
	Hydrogen	5.128	13.587	5.828	1.450		1.240	5.44	0.43	3.216	3.76	2.631	0.312
	Oxygen								3.04				2.604
	Sulphur	....	0.180	0.030	....	....	....	....	...	....	....	....	....
Soluble in dilute hydrochloric acid.	Chlorine	trace	....	0.009	trace	....	0.010	trace	...	0.010	0.003	0.015	trace
	Carbonic acid	2.410	1.170	1.955	....	....	....	0.08	...	0.106	0.040	0.066	0.016
	Sulphuric acid	2.080	0.423	1.127	0.016	....	0.015	0.004	0.097	0.068	0.007	0.016	0.036
	Phosphoric acid	trace	1.028	0.009	0.004	0.418	0.071	0.026	0.54	0.230	0.090	0.029	trace
	Silicic acid	....	....	0.201	....	....	0.180	...	....	0.203	....	0.856	
	Sesquioxide of iron		1.460	1.058	0.696		0.902	0.90	0.53	1.290	1.370	1.167	
	Sesquiox. of manganese	6.710	....	1.775*	....	0.565	....	....	....	....		*1.165	
	Alumina		4.285	4.476	0.555	0.691	1.497	0.46	0.93	1.244	0.64	1.170	4.070
	Lime	3.590	3.049	4.095	0.063	0.107	0.101	0.36	1.17	0.345	0.42	0.409	
	Magnesia	0.160	0.388	0.745	0.116	0.068	0.145	0.09	0.75	0.233	0.15	0.349	
	Potassa	0.530	0.198	0.324	trace	....	0.052	0.06	0.42	0.257	0.08	0.174	
	Soda	0.060	0.060	0.029		....	0.043		0.66	0.060	....	0.010	
	Chloride of sodium	....	....	....	....	....	....	....	....	....	....	....	
Insoluble in dilute hydrochloric acid.	Silicic acid	66.490	63.504	68.218	89.910	84.120	87.772	81.42	82.79	79.280	83.69	84.699	
	Sesquioxide of iron	0.680	5.443	0.671	1.814	2.921	0.572	1.39	0.72	....	1.34	0.641	
	Sesquiox. of manganese	....		....	....		....	....	....	0.190	....	....	
	Alumina	6.100	7.949	1.318	1.545	6.620	3.338	3.21	1.37	5.370	3.28	4.069	89.960
	Lime	0.530	2.765	3.676	0.857	0.974	0.360	1.27	0.53	0.500	0.83	0.234	
	Magnesia	0.500	0.950	0.117	1.764	0.584	0.174	1.49	0.56	0.210	1.19	....	
	Potassa	1.250	....	1.543	1.155	....	1.404	1.92	0.97	1.230	1.78	0.841	
	Soda	1.310	....	0.045	0.520	....	0.584	0.61	0.77	0.500	0.72	0.727	
Total		100.320	106.461	99.984	100.794	99.708	99.312	100.000	99.547	97.832	100.000	100.958	97.770

*FeO. †NH3.

*Annual report of the Progress of Chemistry and Allied Sciences, by J. Liebig and H. Kopp, vol. 3, 1849, p. 465.

TABLE 24.—ANALYSES OF SOILS OF EUROPE.*

	Number	13			14			15	16	17	18	19	20	21	22
		Bergemann.	Sonnenschein.	Erdmann	Bergemann.	Sonnenschein.	Bothe	Meyer and Brazier.				Schmid.			
		Soil of Havixbec.			Soil of Dalheim.			Flax Soil of: Liefland.	Kurland.	Lithuania.	Esthland.	Russian Black Earth.			
Organic substance.	Carbon	2.065	0.943	1.180	1.743	1.610	0.834								
	Nitrogen	0.591	0.081	0.400	1.609	0.150	trace	4.717	4.030	4.344	4.863	12.65	8.58	5.92	8.98
	Hydrogen	1.086	0.183	0.243	1.260	0.350	0.394								
	Oxygen		0.586	0.667		....	2.951								
	Sulphur	....	....	....	....	0.725	....	....	. ..	....	....	....	....	....	....
Soluble in dilute hydrochloric acid.	Chlorine		0.007	trace	1.418	0.012	trace	....	....	....	....	....	....	....	....
	Carbonic acid	0.470	0.340	0.411	....	0.250	....	....	....	....	....	1.08	0.58	0.25	1.18
	Sulphuric acid	1 615	0.012	0.043	....	0.053	0.031	0.154	0.088	0.121	0.162	....	....	....	....
	Phosphoric acid	....	....	0.229	0.456	....	0.651	0.140	0.054	0.080	0.160	0.06	....	....	0.10
	Silicic acid	....	....	....	1.338	....	....	....	....	....	....	....	....	....	....
	Sesquioxide of iron	0.663	1.148	0.881	1.593	2.590	1.826	1.807	2.877	3.190	2.021	2.36	2.13	2.77	2.85
	Sesquiox. of manganese	....		trace	0.224	0.009	trace	trace	trace	trace	trace	0.18	0.03	0.01	....
	Alumina	0.804	2.024	0.929	4.056	3.570	2.358	1.192	1.873	2.142	2.010	1.12	2.18	1.69	1.22
	Lime	1.454	0.721	0.929	0.691	0.270	0.393	0.375	0.782	0.498	0.795	0.69	0.45	0.23	0.80
	Magnesia	....	0.136	0.216	0.277	0.250	0.748	0.201	0.130	0.180	0.862	0.45	0.02	0.16	0.52
	Potassa	....	0.209	trace	0.181	0.440	trace	0.501	0.324	0.547	0.373	0.19	0.25	0.39	0.23
	Soda	....	0.102	0.653		0.270	1.400	....	0.132	0.045	0.048	0.07	0.10	0.11	0.09
	Chloride of sodium	....	....	....	....	....	....	0.045	0.025	0.042	0.079	....	....	....	....
Insoluble in dilute hydrochloric acid.	Silicic acid	78.273	88.299	86.403	75.332	84.270	75.750	79.842	81.500	85.094	80.568				
	Sesquioxide of iron	1.038	0.655	1.930	2.671	trace	1.294	trace	trace	trace	trace				
	Sesquiox. of manganese	....		trace	....		trace	....	....	....	....				
	Alumina	9.434	3.511	0.265	6.917	4.530	7.738	11.627	6.114	2.245	5.755	81.94	86.05	89.16	84.31
	Lime	2.163	....	2.325	0.370	....	0.507	trace	1.873	0.878	2.012				
	Magnesia	0.364	....	?	....	....	0.369	....	....	....	....				
	Potassa	trace	1.085	0.810	....	0.500	2.898	....	....	....	....				
	Soda		....	trace	....	....	trace	....	....	....	....				
Total		100.020	100.037	98.464	100.136	99.876	99.142	100.101*	99.302*	99.406	99.208*	100.24	100.39	100.60	100.28

*Traces of Phosphoric acid.

*Annual report of the Progress of Chemistry and the Allied Sciences, by J. Liebig and H. Kopp, vol 3, 1849. p 465.

Table 25.—Composition of the soils of Massachusetts, according to Prof. Hitchcock. Geology of Massachusetts, by Edward Hitchcock, L. L. D., vol. 1, pp. 41, 43.

NAME AND LOCALITY OF THE SOIL.	Phosphate of Lime,....	Sulphate of Lime,.....	Carbonate of Lime,....	Soluble Geine,........	Insoluble Geine,.......	Silicates,.............	100 Gr. heated to 300 F., absorbed in 24 hours.	Absorbing power in proportional numbers,...	Specific Gravity,......
Alluvium, Deerfield,	0.9	2.0		3.5	1.2	92.4	3.3	65.	2.44
do Northampton,	1.0	2.4		2.8	4.2	89.6	2.0	40.	2.45
do Deerfield,	0.9	1.6		2.3	1.1	94.1	2.1	42.	2.58
do Northampton,	1.1	0.9		1.2	2.4	94.4	1.2	25.	2·68
do Northfield,	0.6	1.5		2.8	2.8	92.3	2.9	58.	2.55
do Northampton,	0.8	2.8		2.4	0.8	93.2	1.4	28.	2.55
do W. Springfield,	0.7	1.3		3.2	1.2	93.6	3.0	60.	2.46
do Westfield,	1.0	2.6	6.2	2.4	2.7	85.1			2.38
do do.	0.3	0.9		1.5	1.2	96.1			
do Stockbridge,	0.5	2.9		3.3	0.8	92.5	1.9	48.	2.55
do Hadley,	1.0	2.7		2.5	2.3	91.5	5.0	100.	2.46
do Sheffield,	0.5	1.7		1.3	5.2	91.3	3.5	70.	2.53
do Deerfield,	0.8	0.8		2.5	2.4	93.5	2.0	40	2.58
do W. Springfield	0.5	1.0		1.5	1.5	95.5	1.5	30.	2.60
Diluvial Argillaceous, Springfield,	1.2	2.4		4.8	5.8	85.8	6.3	126.	2.31
do do Northampton,	0.8	1.6		4.8	4.6	88.2	6.1	122.	2.37
do do Plym uth,	0.9	1·8		2.9	4.9	89.5	4.9	98.	2.34
do do Barnstable,	0.6	0.9		4.4	5.9	88.2	4.9	98.	2.39
do do Sandwich,	1.1	3.0		2.8	4.9	88.2	4 2	84.	2.37
dc Sandy Wareham,	0.4	0.4		0.5	0.0	98.7	0.5	10.	2.37
do do Springfield,	0.6	1.6		3.2	0-0	94.6	1.7	34.	2.60
do do Northampton,	0.5	0.5		3.6	4.4	91.0			
do Loamy, Amherst,	0.9	2.5		3.5	2.3	90.8			2.37
do Sandy, Sheffield,	0.08	3.2		0.0	0.8	98.8			2.66
do do Truro,	0.35		20.3	3.7	1.6	73.1	1.7	34.	
do do Barnstablo,	0.3	0.1		0.0	0.0	99.6	0.8	16.	2.72
do do Gloucester,						100.	0.7	14.	2.71
Sandstone, (Red) Deerfield,	0.7	0.8		0.3	2.6	95.6	3.4	68.	2.53
do do Longmeadow,	0.6	3.2		3.2	0.5	92 5	3.2	64.	2.43
do do Wilbraham,	0.8	1.0		6.1	1.2	90.1	2.5	50.	2.60
do do W. Spri field,	0 7	4.2		4.1	4.2	88.1	2.7	54.	2.46
do (Gray) Granbury,	0.8	0.6		2.7	1.1	94.1	3·0	60.	2.61
Graywacke Soil, Dorchester,	1.0	1.8		7.6	2.4	97.5	4.5	90.	2.37
do Roxbury,	1.4	2.3		4.4	2.8	88.1	3.9	78.	2.43
do Brookline,	1.4	3.1		6.0	0.8	84.2	5.8	116.	2.34
do Walpole,	0.8	1.9		2·6	1.2	89.2	3.1	62.	2.31
do Dighton,	0.5	1.9		2.1	2.7	92.1	1.5	30.	2.34
do Middleborough,	0.9	2.1		1.2	1.2	92.1	1.6	32.	2.48
do Quincy,	1.5	2.4		2.1	0.8	90.0	3.5	70.	2.44
do W. Bridgewater,	0.6	1.2		3.4	2.3	92.6	2.5	50.	2.40
do Watertown,	1.1	1.9	1.3	5.6	5.2	94.6	4.6	92.	2.27
do Halifax,	0.8	0.3		3.3	2.4	92.9	1.0	20.	2.45
do Cambridge,	0.2	1.8		2.8	1.5	91.7	2.6	52.	2.45
do Taunton,	0.8	1.8		4.7	5.8	90.3	1.8	36.	2.44
do Attleborough, east part,	0.6	0.5		2.0	4.6	92.8	2.8	56.	2.48
do do West part,	2.0	1.9		2.5	4.9	87'0	3.7	72.	2.21
Argillaceous Slate, Lancaster,	0.9	4.6		5.0	5.9	85.0	5.6	112.	2.25
do do Sterling,	0.5	1.8		6.1	4.9	87.0	2.6	52.	2.32
do do Townsend,	1.0	1.0		6.2	0.0	86.8	3.5	70.	2.81
Argillaceous Slate Soil, Lancaster,	1.0	2.0		7.9	0.0	85.2			
do do do Boston,	1.0	2.5	3.0	4.0	4.4	82.2			2.85
Limestone, (Magnesian) Marlborough,	2.0	1.4		4.4	2.3	91.7	3.0	60.	2.43
do Lanesborough,	4.2	1.1		3.0	0.8	90.9	3.6	72.	2.39
do Great Barrington,	6.0	1.7		3.6	1.6	89.2	3.5	70.	2.56
do Adams,	3.3	1.5		2.2	0.0	92.6	2.8	56.	2.46
Limestone Soil, Sadde Mt. Adams,	0.6	0r1	1.5	0.7	3.3	93.8			2.58
do do Richmond,	0.8	0.8	0 8	2.6	2.1	92.9			2.39
do do South Lee,	0.7	0.6		2.1	2.3	94.3			
do do Egremont	0.7	1.8		1.4	1.5	94.6			2.46
do do Williamstown,	0.6	2.8		3.1	2.0	91.5	5.5	110.	2.39
do do Stockbridge,	0.7	3.9		2.3	5.2	87.9	6.0	120.	2.45
do do Pitsfield,	0.7	1.0		5.4	5.3	97.6	3.0	60.	2.39
do do Sheffield,	0.5	1.8	0.8	2.7	4.2	90.0	5.1	102.	2.27
do do W. Stockbridge,	1.6	1.0	3.2	4.0	5.2	85.0	4.5	90.	2.39
Mica Slate Soil, West Boylston,	0.6	0.9		6.0	5.1	87.4	4.2	84.	2.31
do do do Webster,	1.0	1.3		5.5	3.1	99.1	5.5	110.	2.31
do do do Lunenburg,	1.1	0.8		5.0	3.4	89.7	4.3	86.	2.29
do do do Stockbridge,	1.5	0.2		3.0	5.5	89.8	5.3	106.	2.40
Mica Slate Soil, Chester Village,	1.5	1.5		6.0	3.5	87.5	4.7	64.	2.41
do do do Bradford,	1.2	2.0		6.5	6.8	83.5	6.5	130.	2.26
do do do West Newbury,	1.0	3.5		3.0	5.5	87.0	4.8	96.	2.37
do do do Methuln,	0.6	1.5		2.9	2.2	92.8	0.9	18.	2.53
do do do Pepperell,	0.7	1.6		3.8	7.0	86.9	6.2	124.	2.27

TABLE 25.—SOILS OF MASSACHUSETTS—CONTINUED.

NAME AND LOCALITY OF THE SOIL.	Phosphate of Lime,...	Sulphate of Lime,...	Carbonate of Lime,...	Soluble Geine,...	Insoluble Geine,...	Silicates,...	100 Gr. heated to 300 F. absorbed in 24 hours,.	Absorbing power in proportional numbers...	Specific Gravity,...
do do do Norwich,	0.6	1.2		4.1	4.3	89.8	5.3	106.	2.33
do do do Conway,	1.1	1.7		2.0	4.5	90.7	3.2	64.	2.59
do do do Russell,	0.5	2.7		3.8	6.0	87.0			
do do do West Newbury,	0.9	3.0		5.9	5.7	85.5			
Talcose Slate Soil, Chester,	1.0	3.1		1.5	2.1	92.3	3.1	62.	2.54
do Charlemont,	0.6	3.7		3.8	2.2	92.0	3.5	70.	2.45
do Becket,	1.1	1.4		8.5	2.2	82.0			
do Rowe,	1.6	2.5		4.1	4.6	87.2			2.35
do Mount Washington,	1.5	1.7	2.0	2.6	4.7	87.5			2.33
Talco-Micaceous Slate, Florida,	2.0	2.4		3.2	8.4	84.0	5.8	116.	2.35
do Hancock,	1·0	1.5		6.2	5.8	85.5	2.3	46.	2.31
Gneiss Soil, Tewksbury.	0.8	1.2		4.3	3.9	89.8	3.5	70.	2.41
do Stow,	1.0	2.0		4.0	3.0	90.0	3.8	76.	2.41
do Bolton,	0.9	2.1		4.6	3.4	89.0	3.8	76.	2.40
do Uxbridge,	0.9	2.9		2.6	3.0	90.6	3.5	62.	2.36
do Mendon,	0.7	2.4		2.6	2.5	91.8	3.4	68.	2.51
do Tyngsborough,	0.6	0.6		4.5	1.8	92.5	2.6	52.	2.45
do Holden,	1.4	1.4		3.9	4.7	88.6	5.0	100.	2.37
do Dudley,	0.7	1.9		4.0	4.6	88.8	5.3	106.	2.35
do Templeton,	0.5	2·7		5.2	4.1	89.5	5.1	102.	2.26
do Rutland,	1.2	1.9		7.1	5.3	84.5	6.5	130.	2.27
do Westminster,	0.7	2.2	3.0	5.3	3.8	85.0	4.6	92.	2.26
do Royalston,	0.6	1.9		6.0	3.6	87.9	5.4	108.	2.27
do Fitchburg,	0.7	1.0	2.1	5.4	3.3	87.5	3.4	68.	2.44
do Petersham,	0.4	2.4		5.7	4.8	86.7	4.5	90.	2.36
do New Braintree,	0.8	1.7		6.0	6.3	85.2	6.7	134.	2.34
do Palmer,	0.6	2.1		5.7	2.7	88.8	2.6	52.	2.49
do Enfield,	1.0	2.5		7.2	4.9	84.4	6.4	124.	2.29
do New Salem,	0.7	1.5		3.2	2.7	91.9	3.7	74.	2.44
do Leverett,	0.7	2.8		3.3	3.7	89.5	4.4	88.	2.49
do Hardwick,	0.6	2.1		6.3	3.3	87.7	4.9	98.	2.36
do Ware,	0.6	1.9		5.3	0.7	91.5	2.3	46.	2·58
do Grafton,	0.6	2.1		4.5	3.5	89.3	5.4	108.	2.39
do Bumfiald,	0.4	1.0		5.3	2.1	91.2	3.7	74.	2.46
do Leicester,	1.3	2.8		3.9	2.9	89.1	5.2	104.	2.48
do Otis,	1.1	1.8		4.7	5.4	87.0	6.0	230.	2.34
do Becket,	1.1	2.9		8.3	2.4	85.3	6.0	120.	2.27
do Sandesfield,	1.5	2.5	2.8	3.2	3.3	86.7			2.32
do Tolland,	1.0	3.9		5.2	3.8	86.1			2.28
do Northfield,	1.9	1.5		1.3	3.0	93.2			2.34
do Buckland,	0.7	2.1		5.4	2.0	89.8	2.8	56.	2.51
do Wareham,	0.4	1.2		2.0	0.6	95.8	0.9	18.	2.66
do Stonbridge,	0.4	2.3		5.1	3.7	88.5	2.7	54.	2.50
do Brumfield,	0.5	1.1		0.6	3.8	94.0	3.7	74.	2.60
do West Brookfi ld,	0.5	1.6		1.5	5.1	91.3	4.7	94.	2.66
do Oakham,	0.3	1.4		4.8	2.2	91.3	3.0	60.	2.55
do Athol, decomposing Gneiss,	0.3	2.7		0.3	5.3	92.1	3.0	60.	2.60
Granite Soil, West Hampton,	0.8	1.6		1.2	4.0	92.4	2.2	44.	2.60
do Concord,	0.5	1.6		7.1	2.0	88.8	2.5	50.	2.50
do Duxbury,	0.7	0.8		4.0	2.0	92.5	2.4	48.	2.43
do Andover,	0.6	1.6		5.1	7.5	85.2	4.4	88.	2.29
Sienite Soil, Lynnfield,	0.6	1.4		5.1	5.2	87.7	4.4	88.	2.29
do Marblehead,	0.6	2·7		5.1	5.0	86.6	5.8	116.	9.35
do Manchester,	0.6	0.8		6.5	3.4	88.7	4.0	80.	2.49
do Glouchester,	0.3	1.5		2.4	2.2	93.6	2.8	56.	2.25
do Lexington,	0.6	2.6		5.4	3.9	87.5	6.5	130.	2.24
do Danvers,	0.7	2.7		3.8	6.9	85.9	5.0	100.	2.34
do Newbury,	0.5	1.0		5.0	5.5	88.0	5.3	106.	2.35
do Dedham,	1.3	1.0		7.0	4.7	86.0	6.2	124.	2.24
do Wrentham,	1.5	0.8	0.4	5.6	5.6	86.1	3.6	72.	2 42
do New Bridgewater,	0.7	2.5		2.2	5.9	88.7	3.7	74.	2.36
do Weymouth,	0.7	2.2		2.6	5.1	89.5	4.0	80.	2.35
do Sharon,	0.5	1.7		6.9	3.2	87.7	3.2	64.	2.35
do Mansfield,	0.8	1.1		1.9	2.9	93.6	3.7	74.	2.42
do Abington,	0.8	1.5		2.7	3.7	91.3	2.7	54.	2.46
Porphry Soil, Kents Island,	0.4	3.3		5.7	4.6	86.0	6.3	126.	2.26
do Medford,	0.8	2.6		8.7	4.2	83.7	6.6	132.	2.17
Porphry Soil, Malden,	1.6	3.5		5.2	4.1	85.6	6.8	136.	2.26
do Lynn,	0.6	1.8		4.3	3.5	89.8	5.9	118.	2.29
Greenstone Soil, Ipswich,	0.2	0 7		2.8	9.4	85.9	3.6	72.	2.22
do Woburn,	1.2	1.3		7 7	4.6	85.2	6.0	120.	2.27
do Deerfield,	0.3	0.1	2.0	3.2	4.3	99.1	2.7	54.	2.51
do Belchertown,	1.0	2.4		2.3	4.6	89.7			2.53
SOILS OF ILLINOIS AND OHIO.									
Rushville, Illinois,	0.6	3.4	1.5	7.4	2 5	84.6	6.3		
Sangamon County, Illinois,	0.4	1.2	1.3	4.9	5.6	86.6	6.3		
Lazelle County, do.	0.4	1.4	3.3	7.6	13.8	73.5	9.5		
Peoria do do.	1.0	3.5		3.1	4.8	87.6	5.7		
Scioto Valley, Ohio,	0.9	2.1	2.8	4.5	6,7	83.0	5.3		

TABLE 26—COMPOSITION OF THE SOILS OF NEW YORK, ACCORDING TO PROFESSOR E. EMMONS, Natural History of New York, Part 5, Agriculture, vol. i, Albany, 1846, pp. 238-346.

NAME AND LOCALITY OF SOIL.	Water as moisture	Organic matter	Silex	Peroxide of iron and alumina	Carbonate of Lime	Magnesia	Carbonate of Magnesia	Carbonate of Potash	Phosphate of Lime	Chlorine	Sulphate of Lime	Phosphoric Acid	Peroxide of Iron	Alumina	Phosphate of Alumina	Manganese	Potash
HIGHLAND DISTRICT.—Granitic Soil, Elizabethtown,	2.00	1.00	94.00	2.50	0.50	trace			trace								
" " " " Lewis county	4.00	3.25	85.25	5.00	1.00	0.12			trace								
" " " " " "	1.00	2.50	94.00	2.00	0.25	0.00			trace								
" " " " " "	3.00	2.00	92.00	2.50	0.50	trace			trace								
" " Argillaceous Soil, Tertiary Clay,	5.00	4.20	80 00	8.25	2.40	0.10			trace								
" " Tertiary Clay, Lake Champlain,	2.249	4.24	60.16	7.79	0.94		0.60	0.11	trace	trace	none						
SOUTHERN HIGHLAND DISTRICT.—Granite Soil,	2.79	7.65	75.83	12.00	1.15	0-68			trace								
" " " " " Sub-soil	1.76	4.12	80.79	12.00	0.85	0.60			trace								
" " " " " " "	1.13	3.00	81.67	12.21	0.83	1.16			trace								
TACONIC DISTRICT.—Soil of Petersburgh,	4.50	4.00	81.78		0.75	0.50					0.15	0.02	4.00	3.70			
" " " " Chatham,	3.50	8.50	76.00		0.75	0.50						1.02	7.10	3.50			
" " " " "	4.10	6.25	78.75		0.75	0.75							4.45	4.85			
" " " " Hoosic Corners,	4.25	12.69	69.78		1.76	1.30							5.55	3.42	1.15		
" " " " Hoosic-falls,	2.00	7.12	78.77	8.81	1.00	1.02			0.12								
" " " " " "	3.00	5.50	78.20	10.52	1.52	0.33											
" " " " East Salem,	3.50	6.00	79.00	5.75	0.87	0.75								4.20			
" " " " Schodack,	4.25	6.75	79.75		0.50								2.75	4.50			
" " " " Roofing Slate,	0.50	2.20	80.72	12.76	1.76	0.40											
" " " " Welch Slate,	0.34	2 30	78.76	16.64	1.36	0.52											
" " " " Fitch's Point, Salem,	1.00	2.50	87.00		1.00								5.20	3.05		0.25	
" " " " " " "	3·50	9.25	77.50	7.12	0.10	0.50			0.06								
" " " in Washington county,	7.18	6.12	79.72	6.12	0.10	0.50			0.60								
" " " " Western part of Schodack,	3.50	6.00	79.75		trace	0.75							5.75	4.25			
" " " " Schodack,	2.07	6.05	85.05		trace	trace							4.87	1.75			
" " " " W. slope of Petersburgh mountain,	2.00	2.75	85.00	6.75	3.00	0.50											
" " " " Surface Soil of Peekskill,	2.10	3.70	87.50	6.60	0.30	trace											
" " " " Caldwell,	0.94	2.34	83 84	10.04	3.00	trace											
" " " Brick Clay, Caldwell,	1.16	5.52	65.60	18.52	3.92	trace											

TABLE 26—COMPOSITION OF THE SOILS OF NEW YORK.—CONTINUED.

NAME AND LOCALITY OF SOIL.	Water as moisture	Organic matter..	Silex.............	Peroxide of Iron and Alumina.....	Carbonate of Lime....	Magnesia..	Carbonate of Magnesia.......	Carbonate of Potash.....	Phosphate of Lime...........	Chlorine..	Sulphate of Lime.	Phosphoric Acid..	Peroxide of Iron..	Alumina...	Phosphate of Alumina..............	Magnesia.........	Potash.... ....
HUDSON & MOHAWK DISTRICT—Limestone, clay, slate, drift, and granitic soils,																	
" " " Soil of DeGroff's flats, - - - -	4.50	7.37	78.83	6.50	2.00	.40				.03							
" " " " " Fonda, - - - - - - -	3.25	4.20	84.40		.75	.65							4.11	2.63			
" " " " " Trbe's Hill, - - - - - -	4.00	10.50	84.30	6.40	2.08	.40					1.20						
" " " " " Amsterdam, - - - - - -	4.50	4.75	79.50	8.40	1.09	.40											
" " " " " Little Falls, - - - - - -	4.00	12.00	71.78	10.25	1.50	.40			.07								
" " " " " Rome, - - - - - - -	4.00	8.00	76.00	8.30	8.10	.12											
" " " " " " - - - - - - -	3.75	4.25	84.00	5.50	2.50	.15											
" " " " " " - - - - - - -	5.25	9.00	74.80	5.64	5.24												
" " " " " " - - - - - - -	4.25	6.00	80.50	4.94	4.24	trace											
" " " Hudson River Valleys, - - - - -	4.50	5.52	82.88	6.04	.50	.25											
" " " Albany Clay, - - - - - - -	4.25	1.17	69.02	17.24	4.00	3.00					1.00						.14
" " " " " - - - - - - -	9.75		71.92	14.93	1.75	.70											
" " " Albany Clay Stones, - - - - - -	6.28	1.70	30.88	9.42	50.98	.22											
WESTERN OR WHEAT DISTRICT.—Soil of Red Shale near Canastota, -	1.50	2.50	85.00	8.12	2.11	.12									.50		
" " " Soil of Green Shales, - - - - -	10.82	1.30	71.05	9.74	4.00	1.50					.40				.12		
" " " " " " - - - - -	5.25	6.67	77.50	7.75	1.25	1.10					.22						
" " " " " " - - - - -	4.79	5.24	78.25	8.25	1.15	1.20					.20						
" " " Green Lakes in Manlius, - - - -	4.00	6.25	77.00	9.74	3.00	.50											
" " " " " " - - - -	4.00	8.50	79.54	6.49	1.41	trace											
" " " Clay Sub-soil, Cayuga Lake, - - - -		14.36	48.12	24.00	12.60	1.00											
" " " Soil Great Fields, - - - - - -	4.40	10.24	73.12	12.06	.40	.12											
" " " " " " - - - - - -	2.92	6.80	86.94	1 22	.80	.10											
" " " " near Cayuga Lake, - - - - -	2.17	5.03	83.09	8.00	1.50	.15											
" " " Sub-soil " " " - - - - -	3.00	2.87	82.00	8.20	3.00	.30											
" " " Surface soil " " " - - - - -	3.16	7.44	74.00	8.30	6.48	.50					.12						
" " " Sub-soil, - - - - - - - - -	4.15	3.75	80.00	10.00	1.50	.35											
" " " Marcellus Shales of Hamilton Group, - -	2.00		50.00	10.00	36.90	1.00											
" " " Soil resting on Marcellus Shales, - - -	2.00	6.00	81.50	8.00	2.25	.25											
" " " " " " " - - -	4.15	5.06	80.15	3.00	.50	7.05											
" " " " " " " - - -	5.20	6.50	89.05	7.64	2.05	.25											
" " " " " " " - - -	3.00	5.15	78.00	13.00	1.09	trace											
" " " Sub-soil resting on Pentamerus Limestone, -	1.48	2.80	85.90	8.57	.21	.05											
" " " Sub-soil " " " " - -	2.81	4.59	34.64	7.28	.50	.16											

TABLE 26.—COMPOSITION OF THE SOILS OF NEW YORK.—CONTINUED.

NAME AND LOCALITY OF SOIL.	Water as moisture	Organic Matter	Silex	Peroxide of Iron and Alumina	Carbonate of Lime	Magnesia	Carbonate of Magnesia	Carbonate of Potash	Phosphate of Lime	Chlorine	Sulphate of Lime	Phosphoric Acid	Peroxide of Iron	Alumina	Phosphate of Alumina	Magnesia	Potash
WESTERN OR WHEAT DISTRICT.—Soil of Onondaga Limestone	.50	4.85	85.50	7.92	.62	trace											
" " " Shales of Onondaga Salt Group	4.75	6.20	75.62	10.39	.50	2.15											
" " " Soil " " "	4.00	6.50	78.82	4.69	3.71	1.75									.24		
" " " " " " "	3.84	10.44	77.78	4.98	1.30	1.48											
" " " " " resting upon rotten Shale	5.10	5.94	80.40	5.00	2.36	1.08											
" " " " Wheatland, Monroe county	5.70	5.92	80.18	6.40	.40		.28		.12								
" " " " Lockport, Niagara county	3.00	5.00	85.72	5.00	1.00	trace									.04		
" " " " " " "	3.00	7.75	76.92	8.82	2.82	.25									.15		
" " " " " " "	3.61	9.24	70.88	13.50	.34	.04											
" " " Soil reposing upon thin band of limestone at base of Genesee Slate	2.81	5.19	76.50	12.38	1.62	.50											
" " " Surface Soil resting on Genesee Slate	4.04	1.61	81.70	7.50	1.75	.50											
" " " Soil resting on Moscow Shale	2.00	1.12	89.75	4.21	2.18	trace											
" " " " " " "	2.50	8.25	81.50	5.90	.50	.05											
" " " Wheat Soil, Niagara county	3.00	7.75	76.93	8.82	2.82	.25									.15		
" " " Soil " "	1.75	2.25	88.58	4.80	.70	trace											
" " " Washed Sand	1.00	1.00	84.75	3.32	8.04	1.47											
" " " Kempville	2.00	2.50	87.75	4.32	.25	.01											
" " " Sandy Soil, Albion	1.50	1.70	92.82	1.49	2.00										.17		
" " " Soil Genesee flats	12.25		74.65	8.75	2.43	1.00											
SOUTHERN DISTRICT.—Soil of Mount Toppin	3.68	6.84	81.32	7.62	.25		.15								trace		
" " " " Lafayette Square	4.68	5.25	82.32	6.62	.25	.12											
" " " near Ithaca	1.94	3.62	87.12	6.28	.60	.12											
" " " from Gainsville	7.60		81.26	10.80	.12	trace											
" " " of Green county	6.00		85.00	8.12	.75	.25											
" " " " Loon Lake	8.50		81.00	10.00	.15	trace											
" " " " Howard	9.50		80.50	9.25	.25	trace											
" " " E. slope Schoharie range	1.50		88.5		.06	trace							3.25	5.28			
" " " Old red Sandstone, Catskill	7.00	5.00	80.00	5.50	.25									3.50			
" " " " " " "	24.00		69.00		.75								2.17	3.07			
ATLANTIC DISTRICT.—Drift Soil, Long Island	6.00		87.87	6.25	.25	trace											
" " " " " "	4.00	3.50	86.86	5.75	trace	trace											
" " " " " "	5.00		87.06	3.75	.8[illegible]	.13											

TABLE 22.—ANALYSES OF SOILS OF EUROPE.*

Number		5			6			7			8		
		Bodeker.	Marchand	Trommer.	Schulze	Schulze	Birner	Schulze	Schulze	Birner.	Genth.	Heintz.	Krocker
		Soil of Cartlow.			Soil of Burg-Bornheim.			Soil of Laasan.			Soil of Turwe.		
Organic substance.	Carbon	0.935	0.979	0.886	1.109	1.147	0.900*	1.285	1.325	1.004*	1.760	1.34	1.290
	Nitrogen	0.076	0.106	0.005	0.102	0.114	1.409†	0.112	0.113	1.812†	0.140	0.13	0.173
	Hydrogen	0.119	1.915 (Hydrogen and Oxygen)	1.749	2.062	1.989	....	2.252	2.165	....	3.615	0.52	2.187 (Hydrogen and Oxygen)
	Oxygen	1.962										2.45	
	Sulphur	0.058	....	0.002	0.008	....	....	0.006	....	....	....	0.009	....
Soluble in dilute hydrochloric acid.	Chlorine	0.014	0.003	0.002	0.002	0.003	0.027	0.005	0.004	0.017	0.010	....	0.005
	Carbonic acid	0.033	0.086	....	....	....	0.098	....	....	0.101	0.077	1.69	2.328
	Sulphuric acid	0.012	0.030	0.030	0.030	0.035	0.023	0.040	0.040	0.031	0.040	0.03	0.022
	Phosphoric acid	0.006	0.007	0.009	0.084	0.072	0.003	0.100	0.107	0.012	0.057	0.20	0.014
	Silicic acid	0.027	0.450	....	0.010	0.018	....	0.014	0.008	....	0.701	...	0.196
	Sesquioxide of iron	1.169	1.210	1.268	2.520	1.824	2.816	1.652	1.530	1.552	0.459	0.68	0.794
	Sesquiox. of manganese	0.022	0.001	0.181	0.104	0.092	trace	0.124	0.112	trace	trace	....	0.139‡
	Alumina	0.232	1.488	1.439	1.512	1.602	1.228	1.576	1.690	1.184	0.810	1.12	1.040
	Lime	0.391	0.099	0.235	0.212	0.298	0.232	0.144	0.166	0.273	2.062	2.19	3.169
	Magnesia	0.101	0.047	0.097	0.178	0.216	0.299	0.136	0.148	0.217	0.641	0.58	0.043
	Potassa	0.132	0.203	0.160	0.122	0.109	0.159	0.104	0.122	0.121	0.102	0.56	0.113
	Soda	0.271	0.090	0.013	0.030	0.045	0.079	0.058	0.025	0.095	0.047	0.18	0.006
	Chloride of sodinm	....	....	....	....	....	....	....	....	....	....	....	....
Insoluble in dilute hydrochloric acid.	Silicic acid	82.488	85.997	87.461	80.280	79.704	81.988	81.520	81.535	82.908	80.200	83.52	85.810
	Sesquioxide of iron	0.157	1.739	0.324	1.560	1.379	0.988	1.400	8.045 (Sesquioxide of iron and Sesquiox. of manganese)	0.763	1.150	0.56	0.490
	Sesquiox. of manganese	0.110	trace	0.006	....	....	trace	....		trace	0.240	....	....
	Alumina	0.978	3.319	4.380	6.280	6.481	6.692	6.680	....	6.145	3.250	1.67	1.403
	Lime	0.330	0.447	0.192	6.480	0.689	1.805	0.360	0.363	1.201	0.250	0.48	0.222
	Magnesia	6.987	0.361	0.108	0.520	0.536	0.415	0.240	0.155	0.473	0.160	1.10	....
	Potassa	0.792	1.104	0.666	1.440	1.325	0.279	1.040	1.334	0.217	1.010	0.58	0.088
	Soda	0.598	0.083	0.787	0.880	0.883	0.023	0.320	0.358	0.018	1.217	0.87	0.276
Total		100.000 0.192NH3 and 0.044NO5.	100.000	100.000	99.525	98.561	98.463	99.168	99.345	98.144	97.908	100.459	99.808

*Humic acid. †Humin. ‡CuO.

*Annual report of the Progress of Chemistry and the Allied Sciences, by Justus Liebig and H. Kopp, vol. iii, 1849, p. 465.

TABLE 23.—ANALYSES OF SOILS OF EUROPE.*

Number		9			10			11			12		
		Rose.	Kucke.	Krocker.	Rammelsberg.	Kucke	Krocker	Rammelsberg.	Heintz.	Debus.	Rammelsberg.	Krocker.	Knop.
		Soil of Burg-Wegeleben.			Soil of Frankenfelde.			Soil of Jurgaitschen.			Soil of Neuhof.		
Organic substance.	Carbon	2.360	0.013	2.850	0.750	....	0.759	1.03	2.92	3.010	0.48	1.534	1.713
	Nitrogen	0.432	....	0.272	0.079	2.640	0.093	0.24	0.85	0.280	0.13	0.154	0.011
	Hydrogen	5.128	13.587	5.328	1.450		1.240	5.44	0.43	3.216	3.76	2.631	0.312
	Oxygen								3.04				2.604
Soluble in dilute hydrochloric acid.	Sulphur	....	0.180	0.030	....	....	....	....	...	....	....	....	....
	Chlorine	trace	....	0.009	trace	....	0.010	trace	...	0.010	0.003	0.015	trace
	Carbonic acid	2.410	1.170	1.955	....	....	....	0.08	...	0.106	0.040	0.066	0.016
	Sulphuric acid	2.080	0.423	1.127	0.016	....	0.015	0.004	0.097	0.068	0.007	0.016	0.036
	Phosphoric acid	trace	1.028	0.009	0.004	0.418	0.071	0.026	0.54	0.230	0.090	0.029	trace
	Silicic acid	....	....	0.201	....	....	0.180	...	....	0.208	....	0.856	4.070
	Sesquioxide of iron	6.710	1.460	1.058	0.696		0.902	0.90	0.53	1.290	1.870	1.167	
	Sesquiox. of manganese		....	1.775*	....	0.565	....	....	....	....		*1.165	
	Alumina		4.285	4.476	0.555	0.691	1.497	0.46	0.93	1.244	0.64	1.170	
	Lime	3.590	3.049	4.095	0.063	0.107	0.101	0.36	1.17	0.345	0.42	0.409	
	Magnesia	0.160	0.388	0.745	0.116	0.068	0.145	0.09	0.75	0.233	0.15	0.349	
	Potassa	0.530	0.198	0.324	trace	....	0.052	0.06	0.42	0.257	0.08	0.174	
	Soda	0.060	0.060	0.029		....	0.043		0.66	0.060	....	0.010	
	Chloride of sodium	....	....	....		....	....	...	....	....	....	....	
Insoluble in dilute hydrochloric acid.	Silicic acid	66.490	63.504	68.218	89.910	84.120	87.772	81.42	82.79	79.280	83.69	84.699	89.960
	Sesquioxide of iron	0.680	5.443	0.671	1.814	2.921	0.572	1.39	0.72	....	1.34	0.641	
	Sesquiox. of manganese	....		....	....		....	....	....	0.190	....	....	
	Alumina	6.100	7.949	1.313	1.545	6.620	3.338	3.21	1.87	5.370	3.28	4.069	
	Lime	0.530	2.765	3.676	0.857	0.974	0.360	1.27	0.53	0.500	0.83	0.234	
	Magnesia	0.500	0.950	0.117	1.764	0.584	0.174	1.49	0.56	0.210	1.19	....	
	Potassa	1.250	....	1.543	1.155	....	1.404	1.92	0.97	1.230	1.78	0.841	
	Soda	1.810	....	0.045	0.520	....	0.584	0.61	0.77	0.500	0.72	0.727	
Total		100.320	106.461	99.984	100.794	99.708	99.312	100.000	99.547	97.832	100.000	100.958	97.770

*FeO. †NH3.

*Annual report of the Progress of Chemistry and Allied Sciences, by J. Liebig and H. Kopp, vol. 3, 1849, p. 465.

TABLE 24.—ANALYSES OF SOILS OF EUROPE.*

Number		13			14			15	16	17	18	19	20	21	22
		Bergemann.	Sonnenschein.	Erdmann	Bergemann.	Sonnenschein.	Bothe	Meyer and Brazier.				Schmid.			
		Soil of Havixbec.			Soil of Dalheim.			Flax Soil of: Liefland.	Kurland.	Lithuania.	Esthland.	Russian Black Earth.			
Organic substance.	Carbon	2.065	0.943	1.130	1.743	1.610	0.834	4.717	4.030	4.344	4.863	12.65	8.58	5.92	8.98
	Nitrogen	0.591	0.081	0.400	1.609	0.150	trace								
	Hydrogen	1.086	0.183	0.243	1.260	0.350	0.394								
	Oxygen		0.586	0.667		....	2.951								
	Sulphur	....	....	....	....	0.725	....	....	....	....	....	....	....	....	....
Soluble in dilute hydrochloric acid.	Chlorine		0.007	trace	1.418	0.012	trace	....	....	....	....	....	....	....	....
	Carbonic acid	0.470	0.340	0.411	....	0.250	....	....	....	....	....	1.03	0.58	0.25	1.18
	Sulphuric acid	1 615	0.012	0.043	....	0.053	0.031	0.154	0.088	0.121	0.162	....	....	....	....
	Phosphoric acid	....	....	0.229	0.456	....	0.651	0.140	0.054	0.080	0.160	0.06	....	....	0.10
	Silicic acid	....	....	....	1.338	....	....					....	....	....	....
	Sesquioxide of iron	0.663	1.148	0.881	1.593	2.590	1.826	1.807	2.877	3.190	2.021	2.36	2.13	2.77	2.85
	Sesquiox. of manganese	....		trace	0.224	0.009	trace	trace	trace	trace	trace	0.13	0.03	0.01	....
	Alumina	0.804	2.024	0.929	4.056	3.570	2.358	1.192	1.873	2.142	2.010	1.12	2.18	1.69	1.22
	Lime	1.454	0.721	0.929	0.691	0.270	0.393	0.375	0.782	0.498	0.795	0.69	0.45	0.23	0.80
	Magnesia	....	0.136	0.216	0.277	0.250	0.748	0.201	0.130	0.180	0.862	0.45	0.02	0.16	0.52
	Potassa	....	0.209	trace	0.181	0.440	trace	0.501	0.324	0.547	0.373	0.19	0.25	0.39	0.23
	Soda	....	0.102	0.653		0.270	1.400	....	0.132	0.045	0.048	0.07	0.10	0.11	0.09
	Chloride of sodium	....	....	....	....	....	....	0.045	0.025	0.042	0.079	....	....	....	....
Insoluble in dilute hydrochloric acid.	Silicic acid	78.273	88.299	86.403	75.332	84.270	75.750	79.842	81.500	85.094	80.568	81.94	86.05	89.16	84.31
	Sesquioxide of iron	1.038	0.655	1.930	2.671	trace	1.294	trace	trace	trace	trace				
	Sesquiox. of manganese	....		trace	....		trace	....	....	....	....				
	Alumina	9.434	3.511	0.265	6.917	4.580	7.738	11.627	6.114	2.245	5.755				
	Lime	2.163	....	2.325	0.370	....	0.507	trace	1.873	0.878	2.012				
	Magnesia	0.364	....	?	....	....	0.369	....	....	....	....				
	Potassa	trace	1.085	0.810	....	0.500	2.898	....	....	....	....				
	Soda		....	trace	....	....	trace	....	....	....	....				
Total		100.020	100.037	98.464	100.136	99.876	99.142	100.101*	99.302*	99.406	99.208*	100.24	100.39	100.60	100.28

*Traces of Phosphoric acid.

*Annual report of the Progress of Chemistry and the Allied Sciences, by J. Liebig and H. Kopp, vol 3, 1849, p 465.

Table 25.—Composition of the soils of Massachusetts, according to Prof. Hitchcock. Geology of Massachusetts, by Edward Hitchcock, L. L. D., vol. 1, pp. 41, 43.

NAME AND LOCALITY OF THE SOIL.	Phosphate of Lime,....	Sulphate of Lime,......	Carbonate of Lime,....	Soluble Geine,........	Insoluble Geine,.......	Silicates,............	100 Gr. heated to 300 F., absorbed in 24 hours,.	Absorbing power in proportional numbers,...	Specific Gravity,......
Alluvium, Deerfield,	0.9	2.0		3.5	1.2	92.4	3.3	65.	2.44
do Northampton,	1.0	2.4		2.8	4.2	89.6	2.0	40.	2.45
do Deerfield,	0.9	1.6		2.3	1.1	94.1	2.1	42.	2.58
do Northampton,	1.1	0.9		1.2	2.4	94.4	1.2	25.	2·68
do Northfield,	0.6	1.5		2.8	2.8	92.3	2.9	58.	2.55
do Northampton,	0.8	2.8		2.4	0.8	93.2	1.4	28.	2.55
do W. Springfield,	0.7	1.3		3.2	1.2	93.6	3.0	60.	2.46
do Westfield,	1.0	2.6	6.2	2.4	2.7	85.1			2.38
do do,	0.3	0.9		1.5	1.2	96.1			
do Stockbridge,	0.5	2.9		3.3	0.8	92.5	1.9	48.	2.55
do Hadley,	1.0	2.7		2.5	2.3	91.5	5.0	100.	2.46
do Sheffield,	0.5	1.7		1.3	5.2	91.3	3.5	70.	2.53
do Deerfield,	0.8	0.8		2.5	2.4	93.5	2.0	40	2.58
do W. Springfield	0.5	1.0		1.5	1.5	95.5	1.5	30.	2.60
Diluvial Argillaceous, Springfield,	1.2	2.4		4.8	5.8	85.8	6.3	126.	2.31
do do Northampton,	0.8	1.6		4.8	4.6	88.2	6.1	122.	2.37
do do Plymouth,	0.9	1·8		2.9	4.9	89.5	4.9	98.	2.34
do do Barnstable,	0.6	0.9		4.4	5.9	88.2	4.9	98.	2.39
do do Sandwich,	1.1	3.0		2.8	4.9	88.2	4 2	84.	2.37
de Sandy Wareham,	0.4	0.4		0.5	0.0	98.7	0.5	10.	2.37
do do Springfield,	0.6	1.6		3.2	0·0	94.6	1.7	34.	2.60
do do Northampton,	0.5	0.5		3.6	4.4	91.0			
do Loamy, Amherst,	0.9	2.5		3.5	2.3	90.8			2.37
do Sandy, Sheffield,	0.08	3.2		0.0	0.8	98.8			2.66
do do Truro,	0.35		20.3	3.7	1.6	73.1	1.7	34.	
do do Barnstablo,	0.3	0.1		0.0	0.0	99.6	0.8	16.	2.72
do do Gloucester,						100.	0.7	14.	2.71
Sandstone, (Red) Deerfield,	0.7	0.8		0.3	2.6	95.6	3.4	68.	2.53
do do Longmeadow,	0.6	3.2		3.2	0.5	92 5	3.2	64.	2.43
do do Wilbraham,	0.8	1.0		6.1	1.2	90.1	2.5	50.	2.60
do do W. Springfield,	0 7	4.2		4.1	4.2	88.1	2.7	54.	2.46
do (Gray) Granbury,	0.8	0.6		2.7	1.1	94.1	3·0	60.	2.51
Graywacke Soil, Dorchester,	1.0	1.8		7.6	2.4	97.5	4.5	90.	2.37
do Roxbury,	1.4	2.3		4.4	2.8	88.1	3.9	78.	2.43
do Brookline,	1.4	3.1		6.0	0.8	84.2	5.8	116.	2.34
do Walpole,	0.8	1.9		2·6	1.2	89.2	3.1	62.	2.31
do Dighton,	0.5	1.9		2.1	2.7	92.1	1.5	30.	2.34
do Middleborough,	0.9	2.1		1.2	1.2	92.1	1.6	32.	2.48
do Quincy,	1.5	2.4		2.1	0.8	90.0	3.5	70.	2.44
do W. Bridgewater,	0.6	1.2		3.4	2.3	92.6	2.5	50.	2.40
do Watertown,	1.1	1.9	1.3	5.6	5.2	94.6	4.6	92.	2.27
do Halifax,	0.8	0.3		3.3	2.4	92.9	1.0	20.	2.45
do Cambridge,	0.2	1.8		2.8	1.5	91.7	2.6	52.	2.45
do Taunton,	0.8	1.8		4.7	5.8	90.3	1.8	36.	2.44
do Attleborough, east part,	0.6	0.5		2.0	4.6	92.8	2.8	56.	2.48
do do West part,	2.0	1.9		2.5	4.9	87·0	3.7	72.	2.21
Argillaceous Slate, Lancaster,	0.9	4.6		5.0	5.9	85.0	5.6	112.	2.25
do do Sterling,	0.5	1.8		6.1	4.9	87.0	2.6	52.	2.32
do do Townsend,	1.0	1.0		6.2	0.0	86.8	3.5	70.	2.31
Argillaceous Slate Soil, Lancaster,	1.0	2.0		7.9	0.0	85.2			
do do do Boston,	1.0	2.5	3.0	4.0	4.4	82.2			2.35
Limestone, (Magnesian) Marlborough,	2.0	1.4		4.4	2.3	91.7	3.0	60.	2.43
do Lanesborough,	4.2	1.1		3.0	0.8	90.9	3.6	72.	2.39
do Great Barrington,	6.0	1.7		3.6	1.6	89.2	3.5	70.	2.56
do Adams,	3.3	1.5		2.2	0.0	92.6	2.8	56.	2.46
Limestone Soil, Sadde Mt. Adams,	0.6	0·1	1.5	0.7	3.3	93.8			2.58
do do Richmond,	0.8	0.8	0 8	2.6	2.1	92.9			2.39
do do South Lee,	0.7	0.6		2.1	2.3	94.3			
do do Egremont,	0.7	1.8		1.4	1.5	94.6			2.46
do do Williamstown,	0.6	2.8		3.1	2.0	91.5	5.5	110.	2.39
do do Stockbridge,	0.7	3.9		2.3	5.2	87.9	6.0	120.	2.45
do do Pitsfield,	0.7	1.0		5.4	5.3	97.6	3.0	60.	2.39
do do Sheffield,	0.5	1.8	0.8	2.7	4.2	90.0	5.1	102.	2.27
do do W. Stockbridge,	1.6	1.0	3.2	4.0	5.2	85.0	4.5	90.	2.39
Mica Slate Soil, West Boylston,	0.6	0.9		6.0	5.1	87.4	4.2	84.	2.31
do do do Webster,	1.0	1.3		5.5	3.1	99.1	5.5	110.	2.31
do do do Lunenburg,	1.1	0.8		5.0	3.4	89.7	4.3	86.	2.29
do do do Stockbridge,	1.5	0.2		3.0	5.5	89.8	5.3	106.	2.40
Mica Slate Soil, Chester Village,	1.5	1.5		6.0	3.5	87.5	4.7	64.	2.41
do do do Bradford,	1.2	2.0		6.5	6.8	83.5	6.5	130.	2.26
do do do West Newbury,	1.0	3.5		3.0	5.5	87.0	4.8	96.	2.37
do do do Methuin,	0.6	1.5		2.9	2.2	92.8	0.9	18.	2.53
do do do Pepperell,	0.7	1.6		3.8	7.0	86.9	6.2	124.	2.27

TABLE 25.—SOILS OF MASSACHUSETTS—CONTINUED.

NAME AND LOCALITY OF THE SOIL.	Phosphate of Lime	Sulphate of Lime	Carbonate of Lime	Soluble Geine	Insoluble Geine	Silicates	100 Gr. heated to 300 F. absorbed in 24 hours	Absorbing power in proportional numbers	Specific Gravity
do do do Norwich,	0.6	1.2		4.1	4.3	89.8	5.3	106.	2.33
do do do Conway,	1.1	1.7		2.0	4.5	90.7	3.2	64.	2.59
do do do Russell,	0.5	2.7		3.8	6.0	87.0			
do do do West Newbury,	0.9	3.0		5.9	5.7	85.5			
Talcose Slate Soil, Chester,	1.0	3.1		1.5	2.1	92.3	3.1	62.	2.54
do Charlemont,	0.6	3.7		3.8	2.2	92.0	3.5	70.	2.45
do Becket,	1.1	1.4		8.5	2.2	82.0			
do Rowe,	1.6	2.5		4.1	4.6	87.2			2.35
do Mount Washington,	1.5	1.7	2.0	2.6	4.7	87.5			2.33
Talco-Micaceous Slate, Florida,	2.0	2.4		3.2	8.4	84.0	5.8	116.	2.35
do Hancock,	1·0	1.5		6.2	5.8	85.5	2.3	46.	2.31
Gneiss Soil, Tewksbury	0.8	1.2		4.3	3.9	89.8	3.5	70.	2.41
do Stow,	1.0	2.0		4.0	3.0	90.0	3.8	76.	2.41
do Bolton,	0.9	2.1		4.6	3.4	89.0	3.8	76.	2.40
do Uxbridge,	0.9	2.9		2.6	3.0	90.6	3.5	62.	2.36
do Mendon,	0.7	2.4		2.6	2.5	91.8	3.4	68.	2.51
do Tyngsborough,	0.6	0.6		4.5	1.8	92.5	2.6	52.	2.45
do Holden,	1.4	1.4		3.9	4.7	88.6	5.0	100.	2.37
do Dudley,	0.7	1.9		4.0	4.6	88.8	5.3	106.	2.35
do Templeton,	0.5	2·7		5.2	4.1	89.5	5.1	102.	2.26
do Rutland,	1.2	1.9		7.1	5.3	84.5	6.5	130.	2.27
do Westminster,	0.7	2.2	3.0	5.3	3.8	85.0	4.6	92.	2.26
do Royalston,	0.6	1.9		6.0	3.6	87.9	5.4	108.	2.27
do Fitchburg,	0.7	1.0	2.1	5.4	3.3	87.5	3.4	68.	2.44
do Petersham,	0.4	2.4		5.7	4.8	86.7	4.5	90.	2.36
do New Braintree,	0.8	1.7		6.0	6.3	85.2	6.7	134.	2.34
do Palmer,	0.6	2.1		5.7	2.7	88.8	2.6	52.	2.49
do Enfield,	1.0	2.5		7.2	4.9	84.4	6.4	124.	2.29
do New Salem,	0.7	1.5		3.2	2.7	91.9	3.7	74.	2.44
do Leverett,	0.7	2.8		3.3	3.7	89.5	4.4	88.	2.49
do Hardwick,	0.6	2.1		6.3	3.3	87.7	4.9	98.	2.36
do Ware,	0.6	1.9		5.3	0.7	91.5	2.3	46.	2·58
do Grafton,	0.6	2.1		4.5	3.5	89.3	5.4	108.	2.39
do Bumfield,	0.4	1.0		5.3	2.1	91.2	3.7	74.	2.46
do Leicester,	1.3	2.8		3.9	2.9	89.1	5.2	104.	2.48
do Otis,	1.1	1.8		4.7	5.4	87.0	6.0	280.	2.34
do Becket,	1.1	2.9		8.3	2.4	85.3	6.0	120.	2.27
do Sandesfield,	1.5	2.5	2.8	3.2	3.3	86.7			2.32
do Tolland,	1.0	3.9		5.2	3.8	86.1			2.28
do Northfield,	1.0	1.5		1.8	3.0	93.2			2.34
do Buckland,	0.7	2.1		5.4	2.0	89.8	2.8	56.	2.51
do Wareham,	0.4	1.2		2.0	0.6	95.8	0.9	18.	2.68
do Stonbridge,	0.4	2.3		5.1	3.7	88.5	2.7	54.	2.50
do Brumfield,	0.5	1.1		0.6	3.8	94.0	3.7	74.	2.60
do West Brookfi ld,	0.5	1.6		1.5	5.1	91.3	4.7	94.	2.68
do Oakham,	0.3	1.4		4.8	2.2	91.3	3.0	60.	2.55
do Athol, decomposing Gneiss,	0.3	2.7		0.3	5.3	92.1	3.0	60.	2.60
Granite Soil, West Hampton,	0.8	1.6		1.2	4.0	92.4	2.2	44.	2.60
do Concord,	0.5	1.6		7.1	2.0	88.8	2.5	50.	2.50
do Duxbury,	0.7	0.8		4.0	2.0	92.5	2.4	48.	2.43
do Andover,	0.6	1.6		5.1	7.5	85.2	4.4	88.	2.29
Sienite Soil, Lynnfield,	0.6	1.4		5.1	5.2	87.7	4.4	88.	2.29
do Marblehead,	0.6	2·7		5.1	5.0	86.6	5.8	116.	9.35
do Manchester,	0.6	0.8		6.5	3.4	88.7	4.0	80.	2.49
do Glouchester,	0.3	1.5		2.4	2.2	93.6	2.8	56.	2.25
do Lexington,	0.6	2.6		5.4	3.9	87.5	6.5	130.	2.24
do Danvers,	0.7	2.7		3.8	6.9	85.9	5.0	100.	2.34
do Newbury,	0.5	1.0		5.0	5.5	88.0	5.3	106.	2.35
do Dedham,	1.3	1.0		7.0	4.7	86.0	6.2	124.	2.24
do Wrentham,	1.5	0.8	0.4	5.6	5.6	86.1	3.6	72.	2 42
do New Bridgewater,	0.7	2.5		2.2	5.9	88.7	3.7	74.	2.36
do Weymouth,	0.7	2.2		2.6	5.1	89.5	4.0	80.	2.35
do Sharon,	0.5	1.7		6.9	3.2	87.7	3.2	64.	2.35
do Mansfield,	0.8	1.1		1.9	2.9	93.6	3.7	74.	2.42
do Abington,	0.8	1.5		2.7	3.7	91.3	2.7	54.	2.46
Porphry Soil, Kents Island,	0.4	3.3		5.7	4.6	86.0	6.3	126.	2.26
do Medford,	0.8	2.6		8.7	4.2	83.7	6.6	132.	2.17
Porphry Soil, Malden,	1.6	3.5		5.2	4.1	85.6	6.8	136.	2.26
do Lynn,	0.6	1.8		4.3	3.5	89.8	5.9	118.	2.29
Greenstone Soil, Ipswich,	0.2	0 7		2.8	9.4	85.9	3.6	72.	2.22
do Woburn,	1.2	1.3		7 7	4.6	85.2	6.0	120.	2.27
do Deerfield,	0.3	0.1	2.0	3.3	4.3	99.1	2.7	54.	2.51
do Belchertown,	1.0	2.4		2.3	4.6	89.7			2.58

SOILS OF ILLINOIS AND OHIO.

Rushville, Illinois,	0.6	3.4	1.5	7.4	2 5	84.6	6.3		
Sangamon County, Illinois,	0.4	1.2	1.3	4.9	5.6	86.6	6.3		
Lazelle County, do.	0.4	1.4	3.3	7.6	13.8	73.5	9.5		
Peoria do do.	1.0	3.5		3.1	4.8	87.6	5.7		
Scioto Valley, Ohio,	0.9	2.1	2.8	4.5	6.7	83.0	5.3		

TABLE 26—COMPOSITION OF THE SOILS OF NEW YORK, ACCORDING TO PROFESSOR E. EMMONS,
Natural History of New York, Part 5, Agriculture, vol. i, Albany, 1846, pp. 238-346.

NAME AND LOCALITY OF SOIL.	Water as moisture	Organic matter	Silex	Peroxide of iron and alumina	Carbonate of Lime	Magnesia	Carbonate of Magnesia	Carbonate of Potash	Phosphate of Lime	Chlorine	Sulphate of Lime	Phosphoric Acid	Peroxide of Iron	Alumina	Phosphate of Alumina	Manganese	Potash
HIGHLAND DISTRICT.—Granitic Soil, Elizabethtown	2.00	1.00	94.00	2.50	0.50	trace			trace								
" " " " Lewis county	4.00	3.25	85.25	5.00	1.00	0.12			trace								
" " " " " "	1.00	2.50	94.00	2.00	0.25	0.00			trace								
" " " " " "	3.00	2.00	92.00	2.50	0.50	trace			trace								
" " Argillaceous Soil, Tertiary Clay,	5.00	4.20	80.00	8.25	2.40	0.10			trace								
" " Tertiary Clay, Lake Champlain,	2.249	4.24	60.16	7.79	0.94		0.60	0.11	trace	trace	none						
SOUTHERN HIGHLAND DISTRICT.—Granite Soil,	2.79	7.65	75.83	12.00	1.15	0-68			trace								
" " " " " Sub-soil	1.76	4.12	80.79	12.00	0.85	0.60			trace								
" " " " " " "	1.13	3.00	81.67	12.21	0.83	1.16			trace								
TACONIC DISTRICT.—Soil of Petersburgh,	4.50	4.00	81.78		0.75	0.50					0.15	0.02	4.00	3.70			
" " " " Chatham,	3.50	8.50	76.00		0.75	0.50						1.02	7.10	3.50			
" " " " "	4.10	6.25	78.75		0.75	0.75							4.45	4.85			
" " " " Hoosic Corners,	4.25	12.69	69.78		1.76	1.30							5.55	3.42	1.15		
" " " " Hoosic-falls,	2.00	7.12	78.77	8.81	1.00	1.02			0.12								
" " " " " "	3.00	5.50	78.20	10.52	1.52	0.33											
" " " " East Salem,	3.50	6.00	79.00	5.75	0.87	0.75								4.20			
" " " " Schodack,	4.25	6.75	79.75		0.50								2.75	4.50			
" " " " Roofing Slate,	0.50	2.20	80.72	12.76	1.76	0.40											
" " " " Welch Slate,	0.34	2.30	78.76	16.64	1.36	0.52											
" " " " Fitch's Point, Salem,	1.00	2.50	87.00		1.00								5.20	3.05		0.25	
" " " " " " "	3.50	9.25	77.50	7.12	0.10	0.50			0.06								
" " " in Washington county.	7.18	6.12	79.72	6.12	0.10	0.50			0.60								
" " " " Western part of Schodack,	3.50	6.00	79.75		trace	0.75							5.75	4.25			
" " " " Schodack,	2.07	6.05	85.05		trace	trace							4.87	1.75			
" " " " W. slope of Petersburgh mountain,	2.00	2.75	85.00	6.75	3.00	0.50											
" " " " Surface Soil of Peekskill,	2.10	3.70	87.50	6.60	0.30	trace											
" " " " Caldwell,	0.94	2.34	83.84	10.04	3.00	trace											
" " " Brick Clay, Caldwell,	1.16	5.52	65.60	18.52	3.92	trace											

TABLE 26—COMPOSITION OF THE SOILS OF NEW YORK.—CONTINUED.

NAME AND LOCALITY OF SOIL.	Water as moisture	Organic matter..	Silex............	Peroxide of Iron and Alumina.....	Carbonate of Lime....	Magnesia..	Carbonate of Magnesia.......	Carbonate of Potash.....	Phosphate of Lime...........	Chlorine..	Sulphate of Lime.	Phosphoric Acid..	Peroxide of Iron..	Alumina...	Phosphate of Alumina.............	Magnesia.........	Potash.... ....
HUDSON & MOHAWK DISTRICT—Limestone, clay, slate, drift, and granitic soils,																	
" " " Soil of DeGroff's flats,	4.50	7.37	78.83	6.50	2.00	.40				.03							
" " " " " Fonda,	3.25	4.20	84.40		.75	.65							4.11	2.63			
" " " " " Trbe's Hill,	4.00	10.50	84.30	6.40	2.08	.40					1.20						
" " " " " Amsterdam,	4.50	4.75	79.50	8.40	1.09	.40											
" " " " " Little Falls,	4.00	12.00	71.78	10.25	1.50	.40			.07								
" " " " " Rome,	4.00	8.00	76.00	8.30	8.10	.12											
" " " " " "	3.75	4.25	84.00	5.50	2.50	.15											
" " " " " "	5.25	9.00	74.80	5.64	5.24												
" " " " " "	4.25	6.00	86.50	4.94	4.24	trace											
" " " Hudson River Valleys,	4.50	5.52	82.88	6.04	.50	.25											
" " " Albany Clay,	4.25	1.17	69.02	17.24	4.00	3.00					1.00						.14
" " " " "	9.75		71.92	14.93	1.75	.70											
" " " Albany Clay Stones,	6.28	1.70	30.88	9.42	50.98	.22											
WESTERN OR WHEAT DISTRICT.—Soil of Red Shale near Canastota,	1.50	2.50	85.00	8.12	2.11	.12									.50		
" " " Soil of Green Shales,	10.82	1.30	71.05	9.74	4.00	1.50					.40				.12		
" " " " " "	5.25	6.67	77.50	7.75	1.25	1.10					.22						
" " " " " "	4.79	5.24	78.25	8.25	1.15	1.20					.20						
" " " Green Lakes in Manlius,	4.00	6.25	77.00	9.74	3.00	.50											
" " " " " "	4.00	8.50	79.54	6.49	1.41	trace											
" " " Clay Sub-soil, Cayuga Lake,		14.36	48.12	24.00	12.60	1.00											
" " " Soil Great Fields,	4.40	10.24	73.12	12.06	.40	.12											
" " " " " "	2.92	6.80	86.94	1 22	.80	.10											
" " " " near Cayuga Lake,	2.17	5.03	83.09	8.00	1.50	.15											
" " " Sub-soil " " "	3.00	2.87	82.00	8.20	3.00	.30											
" " " Surface soil " " "	3.16	7.44	74.00	8.30	6.48	.50					.12						
" " " Sub-soil,	4.15	3.75	80.00	10.00	1.50	.35											
" " " Marcellus Shales of Hamilton Group,	2.00		50.00	10.00	36.90	1.00											
" " " Soil resting on Marcellus Shales,	2.00	6.00	81.50	8.00	2.25	.25											
" " " " " " "	4.15	5.06	80.15	3.00	.50	7.0											
" " " " " " "	5.20	6.50	89.05	7.64	2.05	.25											
" " " " " " "	3.00	5.15	78.00	13.00	1.09	trace											
" " " Sub-soil resting on Pentamerus Limestone,	1.48	2.80	85.90	8.57	.21	.05											
" " " Sub-soil " " " "	2.81	4.59	34.64	7.28	.50	.16											

TABLE 26.—COMPOSITION OF THE SOILS OF NEW YORK.—CONTINUED.

NAME AND LOCALITY OF SOIL.	Water as moisture	Organic Matter	Silex	Peroxide of Iron and Alumina	Carbonate of Lime	Magnesia	Carbonate of Magnesia	Carbonate of Potash	Phosphate of Lime	Chlorine	Sulphate of Lime	Phosphoric Acid	Peroxide of Iron	Alumina	Phosphate of Alumina	Magnesia	Potash
WESTERN OR WHEAT DISTRICT.—Soil of Onondaga Limestone	.50	4.85	85.50	7.92	.62	trace											
" " " Shales of Onondaga Salt Group	4.75	6.20	75.62	10.39	.50	2.15											
" " " Soil " " "	4.00	6.50	78.82	4.69	3.71	1.75									.24		
" " " " " " "	3.84	10.44	77.78	4.98	1.30	1.48											
" " " " " resting upon rotten Shale	5.10	5.94	80.40	5.00	2.36	1.08											
" " " " Wheatland, Monroe county	5.70	5.92	80.18	6.40	.40		.28		.12								
" " " " Lockport, Niagara county	3.00	5.00	85.72	5.00	1.00	trace									.04		
" " " " " " "	3.00	7.75	76.92	8.82	2.82	.25									.15		
" " " " " " "	3.61	9.24	70.88	13.50	.34	.04											
" " " Soil reposing upon thin band of limestone at base of Genesee Slate	2.81	5.19	76.50	12.38	1.62	.50											
" " " Surface Soil resting on Genesee Slate	4.04	1.61	81.70	7.50	1.75	.50											
" " " Soil resting on Moscow Shale	2.00	1.12	89.75	4.21	2.18	trace											
" " " " " " "	2.50	8.25	81.50	5.90	.50	.05											
" " " Wheat Soil, Niagara county	3.00	7.75	76.93	8.82	2.82	.25									.15		
" " " Soil " "	1.75	2.25	88.53	4.80	.70	trace											
" " " Washed Sand	1.00	1.00	84.75	3.32	8.04	1.47											
" " " Kempville	2.00	2.50	87.75	4.32	.25	.01											
" " " Sandy Soil, Abion	1.50	1.70	92.82	1.49	2.00										.17		
" " " Soil Genesee flats	12.25		74.65	8.75	2.43	1.00											
SOUTHERN DISTRICT.—Soil of Mount Toppin	3.68	6.84	81.32	7.62	.25		.15								trace		
" " " " Lafayette Square	4.68	5.25	82.32	6.62	.25	.12											
" " " near Ithaca	1.94	3.62	87.12	6.28	.60	.12											
" " " from Gainsville	7.60		81.26	10.80	.12	trace											
" " " of Green county	6.00		85.00	8.12	.75	.25											
" " " " Loon Lake	8.50		81.00	10.00	.15	trace											
" " " " Howard	9.50		80.50	9.25	.25	trace											
" " " E. slope Schoharie range	1.50		88.5		.06	trace							3.25	5.28			
" " " Old red Sandstone, Catskill	7.00	5.00	80.00	5.50	.25									3.50			
" " " " " " "	24.00		69.00		.75								2.17	3.07			
ATLANTIC DISTRICT.—Drift Soil, Long Island	6.00		87.87	6.25	.25	trace											
" " " " " "	4.00	3.50	86.86	5.75	trace	trace											
" " " " " "	5.00		87.06	3.75	.87	.13											

TABLE 27. SOILS OF RHODE ISLAND.

LOCALITIES.	REMARKS.	Water,........	Vegetable Matter,.....	Soluble Mineral Matter,........	Insoluble Silicious Matter,........	Oxide of Iron,........	Alumina,........	Iron and Alumina not separated,........	Salts of Lime,........	Magnesia,........	Mechanical Separation. 1st Sieve	2d Sieve	Fine Pow'd
Barrington, A. Bicknell,	Crop last year, Potatoes,	3.	9.2	7.4	82.0			6.	1.4				
" Dr. I. Mauran,	Subsoil,	3.4	1.1	3.65	90.2			3.53	0.5	0.5	57.	100.	892.
" " "	Crop last year, Potatoes without manure,	1.4	3.9	4.1	89.8			3.7	0.4		18.	200.	782.
" " "	Crop, Corn last year,	1.6	6.4	6.6	85.1			5.9	0.7		97.	150.	758.
" " "	Soil from Garden,	1.9	5.6	6.8	85.3			4.9	1.9		63.	15.	922.
Christopher Smith,	Corn, said to be cold and liable to Moss,	3.	7.	3.15	86.1			2.4	0.3	0.45	126.	247.	627.
Block Island, Jeremiah Clark,	Crop, Corn, soil light and sandy,	2.7	6.1	4.25	85.8			3.95	0.3		105.	95.	800.
" " W. P. Sands,	Crop, Crass, one ton to the acre,	2.45	6.35	4.6	85.8			4.6	tr.		78.	158.	764.
" " N. G. Sands,	Corn,	4.3	3.65	4.5	85.55			3.	1.5		100.	147.	763.
Bristol, J. D. W. Perry,	Papoosesquaws Neck,	2.5	6.1	5.8	85.6			5.3	0.2	0.3	181.	114.	705.
" Mr. Gifford,	No. 1,	1.6	5.4	8.8	86.6			8.5	0.3		35.	87.	878.
" " "	No. 2,	2.	7.2	8.3	82.0			7.6	0.5	0.2	43.	95.	852.
" " "	No. 3,	1.8	9.5	8.6	78.9			7.1	1.5		35.	39.	936.
" Mr. Bullock,	Orchard,	2.8	8.5	7.5	80.6	4.8	1.8		0.9		81.	138.	781.
Centreville, Dr. Harris,	Flat Pond Meadow, subsoil,	2.	4.3	4.1	88.3			3.5	0.4	0.2			1000.
Connanicut Island, N. E. Watson,	Twenty bushels Corn to the acre,	2.4	4.8	3·55	86.	1.75	3.2		1.	0.8	40.	86.	674.
" " D. W. Clark,		1.2	3.4	3.4	91.1			3.35	0.5	tr.	3.	69.	928.
Cranston, Christopher Rhodes,	"Sour High Intervale," sorrel abunpant,	3.9	8.0	3.95	84.1			3.3	0.3	0.35			1000.
" " "	Corn field, sorrel abundant-	1.4	3.1	3.25	92.2			2.3	0.5	0.45	42.	132.	826.
Centreville, Dr. Harris,	Clay,	2.6	2.6	7.4	85.4			6.9	0.5				1000.
Johnson, Mr. Pettis,	Luxuriant Clover field,	3.8	9.5	8.6	78.8			7.9	0.7		30.	83.	937.
Cumberland Hill, F. Brown,	Corn,	2.8	4.5	5.9	86.6			5.4	0.5		70.	73.	857.
Cumberland, J. Whipple,	Forty bushels Corn and 40 bushels barley to the acre,	3.5	6.3	9.6	86.9	4.6	4.6		0.3	0.1	109.	138.	753.
Cranston, George Knight,	Waterman's Mills, trace of Manganese found,	3.6	9.2	9.0	77.8	6.3	2.2		0.5		124.	140.	736.
Cumberland, Mr. Lees.	Corn and Potatoes,	3.7	8.0	10.	77.3			8.4	1.6		218.	152.	630.
Glocester Hill, W. Tourtellot,	Granite Diluvium	5.	12.4	6.2	76.0			6.2			26.	83.	881.
Glocester Chepachet,	Sand Hill,	1.	1.5	4.	92.5	*		3.	0.9	0.1			
Great Neck, L. Clark,		4.	18.6	4.5	83.4			4.	0.5	tr.	10.	88.	902.
Hopkinton,	Greyish White Sand,	0.8	0.9	2.6	95.1			2.6	tr.	tr.	128.	172.	700.
Johnston, Mr. Pettis,	From side of the Road, uncultivated,	2.3	3.6	9.1	84.6	7.2	1.4		08.	0.2	51.	97.	952.
" N. Brown,	Oats manured with Lime,	4.	4.3	9.0	75.3			7.8	09.	0.3	167.	135.	698.
" " "	Oats not limed,	2.	7.4	5.7	85.2			4.9	08.		136.	116.	748.
Little Compton, F. Palmer,	Corn manur'd in the hill with barn manure & pond mud	3.2	10.1	8.9	78.5	4.7	3.2		02.	0.1	186.	135.	679.
" " Subsoil,	From forrest on road to Adamsville, color dark green,	1.5	2.2	5.3	89.			5.5	02.	0.1	296.	140.	664.
" " "	From forrest of Oaks,	2.4	4.2	8.9	83.6	6.4	2.2		08.		165.	100.	735.
" " Dr. Palmer,	Sorrel very abundant, manured with fish,	4.	9.	5.3	83.			5.8	tr.		104.	108.	788.
New Providence, Widow Olney.	Louisquiset Turnpike,	2·9	7.7	6.	83.3			5.9	02.		50.	107.	848.

TABLE 27. SOILS OF RHODE ISLAND—CONTINUED.

LOCATION.	REMARKS.	Water	Vegetable Matter	Soluble Mineral Matter	Insoluble Silicious Matter	Oxide of Iron	Alumina	Iron and Alumina not separated	Salts of Lime	Magnesia	Mechanical Separation. 1st Sieve	2d Sieve	Fine Pow'dr
Louisquiset Turnpike	Chesnut growth, Magnesia and Manganese	2.9	2.5	9.	84.2			4.2		4.8	60.	140.	800.
Mansyille, Mr. Man	Clayey Sand	0.6	1.2	6.6	90.8			5.6	0.8	0.7	15.	20.	965.
Newport, Castle Hill Garden		4.5	10.	8.8	75.3			7.8	1.0	tr.	140.	80.	780.
do N. S. Ruggles		4.8	10.	6.4	73.9	4.4	7.1		1.3	0.7	230.	53.	717.
do Capt. Northam	Four acre lot	2.7	7.1	7.4	81.2			7.2	0.2		49.	66.	885.
do do do	Pond lot	4.5	8.9	3.92	77.4	2.92	5.13			1.	32.	37.	931.
do Judge Clark	Wheat	5.7	10.2	7.7	77.7	3.5	3.3		0.6	0.8	141.	223.	636.
N. Kingston, A. Browning	Corn	2.6	7.7	7 6	81.			7.1	0.4	0.1	15.	104.	881.
do E. Allen	Dark brown swamp mud	4.2	10.4	4.5	75.5			3.9	0.4	0.3	10.	59.	931.
oo H. Cole	Oats	2.4	4.7	5.3	87.3			5.0	0.3		47.	85.	978.
do Mr. Allen	From Garden	3.1	11.6	6.5	77.			6.1	0.4		3.	29.	968.
New Providence, A. Anthoney	No. 1, In natural state, 10 bushels Corn to the acre	1.7	4.1	4.2	88.2	2.10	2.1			tr.	14.	165.	821.
do do do	No. 2, ashed, 1½ tons Clover, or 30 bush. Corn per acre,	1.6	3,45	5.07	88.2	2.	2.07		1.0		44.	161.	798.
do do do	No. 3, manur'd with stable manure & ashed, 60 bs. Corn,	1.5	4.05	3.39	89.1	2.07	1.32		tr.		38.	183.	778.
do dy L. Clark	Clay												
Portsmouth, Gov. Child	Wheat, fish manure, last year	2.8	6.2	6.5	83.4			5.2	0.8	0.5	80.	155.	765.
do do do	Wheat	3.4	10.5	8.1	77.1			7.5	0.6		174.	120.	706.
do do do	Corn large, no manure this yr. below a man'd onion bed	3.8	6.2	8.5	80.4			7.1	1.4		144.	158.	698.
New Providence, A. Anthoney	Potatoes	2.9	5.4	7.4	85.4	3.4	0.7		0.8	2.5	32.	152.	866.
do do do	Potatoes	3.1	10.8	4.2	81.7			3.3	0.8		15.	103.	882.
Seekonk Tristame Burges	Rye, luxuriant	1.8	6.9	7.3	83.7			5.8	1.5		45.	152.	803.
do Dr. Gardner	Corn, barn yard manure, 10 loads per acre	1.6	8.1	9.5	80.5	5.1	2.5		1.9		9.	55.	936.
do do do	Oats	2.0	6.4	6.2	87.			5.5	0.7		10.	85.	905.
do do do	Top Soil	4.8	12.	6.63	76.			6.6	0.05		58.	230.	712.
Smithfield	Forest oaks and chesnuts	3.7	5.6	10.1	80.	6.5	3.2		0.4		67.	190.	843.
do	Soil from decomposed horn blende rock, Harris quar.												
do Arnold	Soil from decomposition of Limestone												
South Kington, Point Judith	Subsoil, Corn												
Smithfield	Clay												
Scituate, B. C. Hopkins	Near Hard Rock	5.6	13.9	13.8	65.6			12.4	1.2	0.2			
Smithfield, T. Smith	Barley	2.0	6.7	5.6	86.1	1.9	3.		0.8		100.	114.	786.
do Mr. Ballou	Oak	1.7	6.8	7.2	83.7			6.4	0.7		56.	129.	825.
do do do	Corn, subsoil	3.4	7.8	9.1	80.3	6.1	2.3		0.2	0.5	120.	108.	772.
do do do	Corn	4.9	12.1	7.8	76.	4.4	3.		0.4		135.	136.	729.
do do Harris	Barley, (some Manganese)	3.2	7.1	6.3	81.8			4.8	0.5	1.0	151.	159.	674.
do do do	Hornblende soil, Corn	5.5	3.8	12.8	67.	3.6	0.3		tr.	3.9	140.	100.	760.
do A. Arnold	Corn, subsoil	2.8	6.0	6.7	83.8			5.5	0.2	0.9	26.	46.	938.

TABLE 27. SOILS OF RHODE ISLAND—CONTINUED.

LOCATION.	REMARKS.	Water,	Vegetable Matter,	Soluble Mineral Matter,	Insoluble Silicious Matter,	Oxide of Iron,	Alumina,	Iron and Alumina not separated,	Salts of Lime,	Magnesia,	Mechanical Separation, 2d Sieve	1st Sieve	Fine Powdr
South Kingston Hill,	Corn,	3.9	10.8	6.0	78.6			5.6	0.4	tr.	146.	106.	758.
do do South Ferry,	Pasture,	2.0	7.6	3.1	86.			2.8	tr.	0.3	15.	58.	727.
do do Plain,	Good Corn,	3.4	9.0	6.5	80.6			6.3	0.2		69.	55.	870.
do do L. Clrrk,	Decomposed Granite,	1.3	2.0	4.9	92.1			3.5	0.8	0.6			
do do J. D. Clark,	Barley,	4.5	12.8	3.3	79.1			3.0	0.3		57.	190.	75.
do Gov. Arnold,	Potatoes not manured,	2.9	11.	5.2	80.6			4.7	0.5		63.	94.	84.
Tiverton, Judge Durfee,		2.5	7.9	8.8	79.7			8.1	0.7		250.	139.	61.
do do do	Oat field,	3.9	8.75	8.35	76.5			7.6	0.3	0.45	210.	96.	69.
do do do	Wheat,	4.2	8.2	7.55	78.6			7.3	0.25		204.	116.	68.
Warwick Neck,:	Capt. Holden,	1.9	7.4	5.2	85.2			5.0	0.2		147.	100.	75.
Woonsocket,	Mica Slate mixed with vegetable matter,	2.2	4.5	12.	81.3			11.	1.0	tr.			
"	Sea weed manure, Corn,												
" Mr. Hotchkiss,	Corn,	1.2	7.4	4.4	90.4	3.5	9.5		0.4		100.	140.	76.
Warwick, Gov. Francis,	Oak forest, large Pine growth,	4.	10.	6.45	78.			6.35	0.1	tr.	78.	104.	818.
Warren Neck, Samuel Mason,	Sand,	3.8	8.6	7.7	79.6	4.7	2.4		0.6		58.	208.	734.
Wawick, Gov. Francis,	Subsoil,	0.5	4.3	4.6	90.			4.4	0.2				1000.
" G. Spencer,	Forty bushels Corn per acre last year,	1.8	3.2	8.41	87.3	2.9	4.5		tr.				998.
West Greenwich, Mr. Dawley,	Grass, lime, manure and gypsum,	2.5	5.4	4.6	86.3			4.3	0.3	tr.	94.	171.	735.
Westerly, Mr. Potter,	Alluvial barren,	2.5	6.	5.2	86.			4.5	0.25	0.45			1000.
West Greenwich, Mr. Dawley,	Corn small,	4.8	11.9	5.85	76.			5.8	0.5		80.	146.	774.
" J. P. Stone,	Hog manure, eight loads per acre,	4.4	13.2	5.7	76.			5.4	0.3	tr.	2.	35.	963.
Westerly, T. W. & S. Potter,	Soil from Orchard,	2.1	5.6	7.6	84.4			6.9	0.7		31.	147.	822.
Wickford, T. C. Sanford,	Corn large,	1.475	4.39	5.85	87.45	2.72	2.62		0.2	0.3	38.	183.	779.
" Judge Pitman,	Manure, peat compost,	2.2	6.1	6.1	85.5			5.5	0.6		23.	129.	848.
" J. C. Sandford,	Corn,	2.1	6.6	6.	84.2			5.8	0.2		152.	64.	781.
Woonsocket, N. Aldrich,		2.3	3.5	7.1	85.4			7.1			127.	82.	771.
Woonsocket,	Moulding sand, bright yellow,	2.4	3.4	5.7	86.6			5.5	tr.	0.2	13.	90.	897.

* Report on the Geological and Agricultural Survey of the State of Rhode Island, by Charles T. Jackson, M. D., 1839.

TABLE 28 —COMPOSITION OF THE SOILS OF SOUTH CAROLINA.

Report on the Geology of South Carolina, by M. Tuomey, pp. 253–261.

NAMES AND LOCALITIES.	Organic Matters....	Phosphate of Lime	Sulphate of Lime..	Phosphoric Acid...	Lime..........	Magnesia.........	Potash and Soda...	Silica.........	Alumina.........	Oxide of Iron.....	Potash..........	Water and Loss....
Granite Soils—Union..............	5.50	....	....	....	.20	.50	trace	82.40	6.20	2.40	....	2.80
.. .. Hills, Grindal Shoals	3.62	....	....	....	.50	.40	.50	84.30	5.80	2.00	....	2.88
.. .. Saluda, near Neely's Ferry..........	2.60	....	....	....	....	1.00	.60	90.00	7.40	3.00	....	5.40
.. .. Newberry............	6.20	....	....	....	.04	....	.06	79.30	5.20	1.75	....	7.45
.. .. Monticello............	7.00	....	....	trace	1.00	.50	.30	80.00	6.30	2.20	....	2.70
.. .. Peay's Ferry.........	2.00	....	....	....	.50	trace	....	75.00	8.00	3.10	....	11.40
.. .. Liberty Hill, Kershaw District..........	2.18	....	....	....	1.00	.40	trace	74.00	10.00	3.50	....	8.92
.. .. Chesterfield..........	1.20	....	....	....	1.00	....	trace	86.20	6.60	2.20	....	2.60
.. .. York village..........	4.50	....	....	....	1.40	.50	.06	71.60	9.40	3.70	....	8.84
Gneiss Soils—Edgefield............	5.30	....	....	....	1.40	1.00	....	80.40	7.62	1.60	.16	2.52
.. .. Abbeville.............	1.20	....	....	....	.60	.75	....	83.00	5.40	2.00	....	7.05
.. .. Tumbling Shoals.......	3.00	trace	....	....	.02	....	....	80.00	7.00	4.00	.50	5.48
.. .. Anderson..............	1.20	....	....	....	1.00	....	....	88.00	5.40	2.30	....	2.10
.. .. Spartanburg............	4.20	trace	....	....	2.00	1.00	....	70.00	8.00	3.00	....	11.30
.. .. Greenville.............	2.60	....	....	....	.40	.50	....	75.00	10.10	2.50	....	8.90
.. .. Glassy mountain, Greenville	6.00	....	....	....	1.00	.06	....	66.60	11.60	4.00	.40	10.34
.. .. Pendleton.............	8.00	....	.80	....	.90	1.00	....	70.00	10.00	2.40	.60	6.30
.. .. residence of J. C. Calhoun................	....	....	....	....	.30	.40	....	80.00	9.80	2.00	.70	6.80
Trap rock soils—Flat woods.......	9.20	....	....	....	2.50	trace	.40	52.00	22.10	9.00	....	4.80
.. .. .. Meadow Woods......	3.40	....	....	....	1.80	.50	trace	53.00	19.30	14.10	....	7.90
.. .. .. Fishing creek, Chester	1.90	trace	....	....	2.90	....	.20	60.00	20.50	8.70	....	6.70
.. .. .. near Cambridge, Abbeville..............	10.05	.10	....	....	4.00	....	.90	48.30	19.36	8.40	....	8.89
.. .. .. Fairfield............	7.30	trace	....	....	3.00	trace	.50	56.00	20.10	6.20	....	6.90
.. .. .. Yorkville............	2.20	....	....	....	2.00	....	....	69.00	16.60	7.20	....	2.50
Hornblende Slate Soils—Laurens..	6.50	....	....	....	2.19	1.00	.50	60.04	13.56	6.30	....	9.91
.. .. .. Greenville...	4.30	trace	....	....	2.00	....	.05	68.40	14.20	7.00	....	4.05
.. .. .. Pendleton...	5.00	....	....	....	1.60	.50	trace	70.10	12.00	8.00	....	2.80
Soils o. the Mica Slates—												
.. .. Abbeville C.H.	6.90	....	....	....	.60	1.00	.70	74.30	8.40	6.00	....	2.00
.. .. Greenville,....	7.00	trace	....	....	1.00	.70	.35	69.40	9.30	4.00	....	8.25
.. .. Pickens.......	3.40	....	....	....	.40	1.00	.25	79.60	6.40	5.00	....	3.95
Soils of Talcose Slates—Lancaster..	6.40	....	....	....	....	1.60	....	70.00	5.00	3.00	....	6.00
.. ..	4.50	trace	....	....	....	1.90	....	80.00	6.00	2.00	....	5.60
Soils of Clay Slates—Edgefield	2.40	....	....	....	trace	.05	trace	80.72	12.00	1.60	....	3.33
.. .. .. Columbia....	6.70	....	....	....	1.00	.50	.40	76.30	10.40	2.00	....	2.70
.. .. .. Lexington....	5.60	....	....	....	.50	trace	.30	80.30	9.00	2.40	....	1.90
Soils of tertiary formation—Aiken..	8.50	trace	...	....	.50	trace	....	77.00	5.000	4.005	....	5.500
.. ..	....	....	....	....	.40	1.60	....	81.00	5.50	3.50	....	8.00
.. .. .. Lexington.....	6.50	trace	....	trace	.60	....	....	80.00	5.60	3.00	....	4.30
.. .. .. Richland......	9.00	....	....	....	1.00	.50	trace	76.50	6.60	2.40	....	4.00
.. .. .. Bennettsville..	5.40	....	....	....	.80	1.00	....	77.30	4.80	5.00	....	5.70
.. .. .. Orangeburg ...	5.60	....	....	....	2.00	.50	trace	66.90	9.60	6.00	....	9.40
.. .. .. Lang Syne....	7.00	....	....	....	1.56	1.00	.50	71.00	8.50	4.00	....	6.44
.. .. .. Statesburg	4.40	....	....	....	.90	trace	....	80.30	6.60	3.70	....	4.10
.. .. .. Darlington	8.00	....	....	....	.06	trace	....	70.00	8.60	5.00	....	8.34
.. .. .. Marion C. H...	3.50	....	....	....	....	trace	.40	78.00	6.60	4.70	....	7.16
.. .. .. Beaufort......	2.60	....	....	....	.60	....	....	86.50	6.00	2.00	....	2.30
.. .. .. Horry.........	9.75	....	....	....	.40	....	trace	67.00	9.60	5.60	....	7.65
.. .. .. Barnwell Dis..	11.00	....	....	....	1.00	....	trace	65.00	10.00	4.30	....	8.70
Alluvial Soils—Tide Swamp.......	27.00	....	....	....	1.00	....	....	55.00	5.50	4.00	....	7.00
.. ..	24.00	....	....	....	.80	....	....	60.00	4.80	4.00	....	6.00
.. ..	14.00	....	....	....	1.00	....	....	70.00	3.50	5.00	....	6.00
.. ..	27.00	....	....	....	1.00	....	....	55.00	5.00	4.00	....	7.20
.. ..	27.20	....	....	....	.50	....	....	57.00	3.00	5.00	....	6.80
.. .. Rice Land.........	20.40	....	....	....	1.10	.50	.40	56.00	9.20	3.00	....	9.40
.. ..	10.60	....	....	....	.80	.50	trace	64.00	41.40	4.00	....	9.30
.. ..	28.00	....	....	....	.50	....	trace	60.00	4.00	2.40	....	5.10

The comparison of these results, developes facts and principles of the greatest value to agriculturists.

We shall in the present report, point out only those more general facts and principles which bear immediately upon the relations of lime to soils and organized beings.

My investigations upon the soils of Georgia will not be completed for a considerable length of time, and I have not therefore classed the partial results, thus far obtained, with these tables. When completed, comparisons will be instituted with the facts here recorded; these tables will, therefore, independently of their present interest, be valuable for future reference.

In examining these tables, with minds occupied with the present subject, the first fact which strikes our attention is, that soils differ greatly in the proportion of lime.

(a.)—*The Proportion of Lime varies in different soils. Cause and influence of this variation.*

If we knew with certainty the chemical constitution of the rocks from which a soil has been derived, and the changes through which it has passed, and the various agencies, chemical and mechanical, to which it has been subjected, we could, in a general manner, not only predict the chemical constitution, but also give the efficient cause of the presence or absence of the various constituents.

Whilst it is an established fact, that all soils were originally produced from the disintegration and decomposition of rocks, effected by various chemical and mechanical agencies, air and water, heat and electricity, currents and waves, and by the slower actions of the vegetable and animal kingdoms; nevertheless, it is often difficult to determine with precision the rocks from which soils have been derived, and it is still more difficult to determine the various agencies to which they have been subjected, and the various chemical and physical changes through which they have passed, for soils are often derived from rocks hundreds of miles distant, as is the case with the soils of the Tertiary and recent formations of Georgia.

When we reflect that the continents now inhabited and cultivated by man, have been in past ages submerged for unnumbered centuries, and that the surface of continents have been formed by the materials resulting from the old rocks, which appear to have been first in a molten condition;

when we reflect that the materials derived from the disintegration of these older rocks, form strata thousands of feet in thickness; when we reflect that the continents have been subjected to various elevations and depressions, standing out for thousands of years above the waters of the ocean, subjected to the slower action of the atmosphere, moisture and the vegetable kingdom, moved by the forces of the sun—submerged for thousands of years, subjected to the action of mighty and irresistable currents, which have conveyed the disintegrated materials thousands of miles from the point of disintegration, we will have a clear explanation of the fact so important to the agriculturist, that soils do not necessarily correspond in chemical constitution with the rocks upon which they lie. We have in the counties of Screven, Burke, Washington, Jefferson, and many others, in the Tertiary formation of Georgia, a clear demonstration that soils do not necessarily contain the same elements as the formations upon which they rest.

Thus, in the region of country to which we refer, we have first the upper layer, the surface soil, composed of the products of decaying vegetation, sand, clay, and various inorganic salts, necessary for vegetation—this varies in depth from one inch to one foot. Beneath this, we have a layer of sand, pebbles, and clay, varying in depth from one to six feet. The pebbles found in this second strata, or more properly subsoil, appear to have been removed from northern regions during the last great geological deluge, which took place after the elevation and consolidation of all the rocks, and subsequent to the deposition of the tertiary clays. In Richmond, and other counties lying to the south of the primitive region, we find that not only were soils and pebbles removed to great distances, by this last great geological deluge, but that large masses of rock have been transported by it, and deep excavations have been made by the currents in the tertiary formation, and filled with sand and pebbles; and that in the vallies of Burke, and other counties, the joint clay has been almost entirely denud-

ed and swept off by this current. Beneath this bed of clay and pebbles, we have the joint clay, resembling chalk, but differing wholly from it in composition, containing only a small proportion of carbonate of lime, apparently deposited at the bottom of a deep still sea, for it contains no pebbles or rocks, of any size, and but very few organic remains. Beneath this bed of joint clay, which varies in thickness from 6 to 60 feet, having in certain localities been greatly denuded by the last great geological deluge, we find the marls and shell limestone of the Eocene formation, which are known in some parts to be more than 300 feet in thickness. Now, whilst the lowest formation, the shell limestone, is almost entirely composed of carbonate of lime, with little or no sand or alumina, the joint clay, immediately above, and resting upon this conglomerate of fossil shells, contains not more than from ½ to 4 per cent. of carbonate of lime, and is composed of sand and alumina, and silicate of alumina and other bodies; and the yellow clay and drift materials resting upon the joint clay, contains still less lime; and the soil which the planters of this region cultivate, contains very little more lime than soils which are entirely removed from lime formations.

With truth then we may affirm that the examination of the chemical constitution of soils reveals great and leading truths to the agriculturist.

If the planter takes the view that soils are in every case derived from the rocks upon which they rest, he would in Burke and Jefferson, and other counties where lime formations underlie the soil, affirm that marling was useless, because the soil must already contain an abundance of lime.

Chemical analysis corrects the error, and leads to the inauguration of that system of culture by which the treasures so bountifully bestowed by Providence, will be made to restore the abused and exhausted soil to a degree of fertility superior even to that possessed in its virgin state.

There are countries, however, in which the soils have been derived from the rocks upon which they lie, and the

character of the soils have been in such cases determined by the physical and chemical composition and properties of the rocks.

Thus, in the Highland district of New York, there are two distinct varieties of soil, derived from the same class of rocks (the primitive rocks); the one derived from the ordinary coarse granite, called potash felspar, contains a large proportion of the silicates of alumina and potash; whilst the other, derived from the lime felspar, belonging to the hyposthene rocks, and composed in great measure of labradorite, and devoid of mica, contains a greater amount of the silicates of lime and alumina.

The soils derived from the latter, are more suitable for the cultivation of wheat than the soils derived from the potash felspar, because they contain more lime.

The soil of the old red sandstone of New York corresponds in its general chemical constitution to the rocks from which it has been derived. It contains but little lime, and, under cultivation, is speedily exhausted, and in order to produce crops, it has been found necessary to add lime with all the manures.

The soils of the wheat district of New York, embracing the central and western counties, which are considered to be equal to any wheat soils in the United States, do not appear to derive their valuable properties of yielding large crops, and of remaining fertile for long series of years of continued culture, so much from the organic matters, as from the inorganic elements derived from the rocks upon which they rest.

The investigations of Professor Emmons,* of New York, upon this wheat district, which extends from the south shore of Lake Ontario to a line drawn through the middle of Cayuga and Seneca lakes, have shown that the great fertility and inexhaustible nature of this wheat soil is due to the fact that it has been derived chiefly from the decomposition of the calcareous shales associated with the lime-

* Natural History of New York Agriculture, vol. 1, pp. 272–275.

stones of the Onondaga salt group, and from the grey and red marl of the Medina sandstone, and from the calcareous shales and slates of the Ontario division.

That the composition of the soils of the wheat district of New York corresponds to the composition of the rocks from which it has been derived, may be determined by comparing the constituents of these soils as recorded in the tables, with the following analyses by Professor Emmons, presenting the composition of the most important rocks from which these soils has been derived:

	Red shale of the Onondaga salt group—Sandy variety......	Red shale of the Onondaga salt group—Marly variety	Soft greenish marl succeeding the red shale, containing cavities in the form of the hollow cubical crystals of chloride of sodium..	Vermicular lime rock occurring with the red and green shales and greenish marl........	Bedded limestones—compact and hard. The soft green shales pass into these compact lime stones............. Analysis by Dr. Beck.	Analysis by Dr. Jackson.
Carbonate of Lime.....	10.25	9.89	43.06	13.76	....	....
Carbonic Acid........	....	....	....	20.62	39.80	41.20
Lime........	....	....	....	....	25.24	25 08
Potash...............	....	....	....	....	....	0.7
Soda........	....	....	....	....	....	2.18
Magnesia....	5.75	0.40	2.17	4.26	18.80	12.87
Phosphate of Alumina and Iron...........	....	0.14	....	....	....	....
Organic Matters......	0.57	0.87	5.00	2.54	....	....
Sulphate of Lime......	....	....	1.06	....	....	....
Sulphuric Acid........	....	....	....	....	....	0.60
Peroxide of Iron and Alumina...	6.25	14.98	13.36		....	....
Silex....	68.25	68.86	34.56	3.30	13.50	10 08
Water....	1.00	6.48	0.56	0.23	1.41	1.18
Soluble Saline matters, consisting of Sulphates of Soda, Magnesia, Chlorides of Sodium, Magnesium and Calcium, Sulphate of Lime and sometimes Alumina....	0.68	2.63	5.50			
Alumina....	....	....	....	5.33	....	3.39
Peroxide of Iron..	....	....	....	a trace.	1.25	3.274

From these several analyses of the rocks from which these valuable wheat soils have been derived, it will be observed—

First, Lime enters largely into their composition. The lime is found in combination with sulphuric acid, carbonic acid and phosphoric acid, and with chlorine. The sulphate of lime appears to be derived principally from the beds of gypsum, which are found amongst the shales.

Second, Magnesia is an important and constant constituent of the shales and limestones. These observations in New York demonstrate that this element, when not in the caustic condition, but combined with carbonic and other acids exerts beneficial influences upon cereals. Observations upon the influence of dolomites (limestones containing a large amount of carbonate of magnesia) in Berkshire, Massachusetts, in England, and in other countries, demonstrate the correctness of the conclusion that magnesia saturated with carbonic acid gas is not injurious to vegetation.

Third. These rocks contain all the salts of soda and potassa, as well as those of lime and magnesia, necessary for vegetables and animals.

Fourth. These rocks also contain organic matters which are supposed to have been derived from the plants and animals which lived at the period of the deposition of these rocks.

According to the returns of the wheat crop of New York from 1844 to 1845, the soils resulting from the decomposition of the older and harder rocks, as those of the Taconic and Hudson and Mowhawk districts, yielded only from 8 to 9¾ bushels to the acre, whilst the soils of the western and central wheat district yielded on an average 15½ bushels to the acre. The differences in the yield of the lands in these regions have been shown by Professor Emmons to be due to differences in the physical and chemical constitution of the soil, and to differences of the chemical and physical constitution of the rocks from which they have been derived.

We might multiply examples to show that a deficiency

of lime causes sterility, whilst its abundance promotes fertility. The following examples, however, in addition to those which we have just recorded, will be sufficient to place the question of the value of lime beyond all doubt or dispute.

Long Island, if we except the drift upon its northern slope, or that which faces the sound, has been recovered from the ocean—it is based upon a reef of rocks upon which sand has been washed up by the waves, the soil is therefore composed almost entirely of washed sand, which is exceedingly porous, and contains but little lime. It yields but poor returns to the agriculturist, unless highly manured. The sea islands upon the sea coast of Georgia have a similar constitution to Long Island, but they are in many cases more productive, on account of the vast number of shells deposited upon them by the Indians, and left upon the surface after the last elevation of the Atlantic coast.

The soil from Schodack, New York, the analyses of which are recorded in the table, contains only a trace of lime and magnesia, is a very poor soil and is soon exhausted by culture.

In Smithfield, Rhode Island, a very luxuriant soil has resulted from the mixture of the detritus of hornblende rock and limestone. The effects of lime in rendering this soil fertile, is demonstrated by the fact that white and red clover, and other sweet grasses spring up upon it as they would do upon carefully limed soils.* The tertiary soils of Rhode Island, on the other hand, are wanting in vegetable matter and lime, and are correspondingly poor and easily exhausted.

The Black Jack lands of York and Chester, South Carolina, which have resulted from the decomposition of porphry, and which contain, according to the analysis of Professor Tuomey, near three per cent. of carbonate of lime, and an appreciable amount of soda and potassa, prove, when pro-

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Jackson's Agricultural Report on Rhode Island, p. 128.

perly drained and cultivated, to be equal to the best grain lands in the State of South Carolina.

From the disintegration of "rotten limestone" are produced the richest prairie soils of the counties of Green, Sumpter and Marengo, in Alabama.

In a still farther examination of these tables, the next fact which strikes our attention is:

(*b.*)—*The proportion of Sand and Clay varies greatly in different soils.*

The texture of soils depends in great measure upon the proportions of sand and clay.

Pure sand forms a soil without any tenacity. The effects of manures speedily vanish upon sandy soils.

Pure clay forms a soil of the greatest tenacity, and a soil which is with difficulty drained.

It would be important and interesting to consider these properties of soils in their relations to drainage, but we must defer the thorough discussion of this subject to the report upon the soils of Georgia, and confine our attention to their relations to lime.

The texture of the soil has important bearings upon the action of lime, and determines in a great measure the amount which should be applied.

And here again a knowledge of the chemical constitution of the rocks from which the soil has been derived is of great importance. The proportion of hard insoluble coarse particles in soils which are generally denominated sand, differ both in physical and chemical characters, according as the rocks from which they have been derived differ in these characters. Thus, we may have a coarse or a fine sand. Thus in the highland or primary districts of New York, the soil is coarse and the quantity of finely divided matter is evidently deficient, because derived from hard rocks which decompose slowly; whilst the soils derived from the Taconic rocks are finer than those of the Primary, and contain a greater proportion of finely divided matter, and yet they are inferior in fineness of division, from the

soils of central and western New York, which have been derived from Sedementary rocks of a newer date, which are still more rapidly decomposed. That texture alone will influence the fertility of a soil, might be illustrated by numerous examples; the following well established facts will, serve to show the effects of division: Soils composed almost entirely of coarse sand silex, allow the salts applied to enrich the soil to be washed out by the rains, and both their capillary power for fluids, and their absorbent power for gases are weak. The power of such soils to absorb moisture, and ammonia, and other gases from the soil, and to draw up by capillary attraction the water from beneath will be greatly increased by comminution or by adding some material which will absorb readily moisture, which will decompose the coarse particles, and thus give tenacity to the soil. Now lime is precisely the substance which accomplishes these effects.

It has been calculated by Professor Leslie that in a soil of gravel, the pores of which are 1-100th of an inch in diameter, water will ascend in these pores by capilliary attraction not more than four inches; whilst if the coarse sand have interstices of only 1-500th of an inch, water will rise through a bed of this sand sixteen inches; and if the pores be still farther diminished to the 1-10000th part of an inch, water will rise in such minute capillary tubes twenty-five and a half feet. The effect of the addition of lime to the soil is to diminish the size of its pores, and thus increase its power of capillary attraction.

The effect of fine division upon gases is well shown in the case of spongy platinum—if a solid piece of ordinary platinum be plunged in a stream of hydrogen gas no effect whatever will pe produced; whilst if finely divided platinum be plunged in the hydrogen, it will condense the gas with such rapidity that it will become red hot, and inflame the gas almost instantaneously. In our own bodies the great changes of life take place in the delicate capillaries and in the minute blood corpuscles,

not more than the 1-3000th part of an inch in diameter. Division promotes contact, and close contact allows the play of those molecular forces which act only at infinitely small distances, and the greatest of these forces, which can alone be excited by close contact is chemical affinity, which generates electricity, and is the great force in all animal and vegetable existence. Chemical action is inseperable from activity upon our globe—it is the great source of force in animals, and whether excited by the sun or by the secondary electrical forces generated in the bowels of the earth, it is the great force upon which vegetation absolutely depends.

The following table will present a condensed view of many of the important physical relations of Lime to Soils :

TABLE 29. Illustrating the physical properties of various Soils. Drawn up from the experiments of M. Schubler.

KIND OF SOIL.	Consistance Tenacity or Friability of Soils. Tenacity of Soil, that of Pure Clay being 100.	Shrinking of Soils during drying. 100 Cubic parts of soil, shrink drying to	Imbibition of Water by Soils. Water absorbed by 100 parts of dry Earth	Disposition of Soils to become dry. 100 parts of the water contained in the soil lose in the course of 4 hours at 66° Fhr.	Hygrometic power of Soils. 77.165 grains troy, of soil spread upon a surface of 141.8 square inches absorbed in 12 hours. Grs. of Water.	24 hours. Grs. of Water.	48 hours. Grs. of Water.	72 hours. Grs. of Water.	Capacity of Soils for Heat. Power of retaining heat, that of Calcaceous sand, being 100.	Time which 234.2 Cubic inches of Soil require to cool from 144° to 70° Fhr. to the temperature of the surrounding air, being about 61° Fhr.	Degrees in which Soils become heated under exposure to the Sun. Highest temperature acquired by the upper larger, the mean temperature of the atmosphere being 25 C. (77, Fhr.) Moist Soil. Degrees Centrigrade.	Dry Soil. Degrees Centrigrade.
Siicious Sand,	0.	100.	25.	88.4	0.	0.	0.	0.	95.6	H,3.27M.	37.25 (99° F.)	44.75 (112°5F.)
Calcareous Sand	0.	100.	29.	75.9	0.154	0.231	0.231	0.231	100.0	3.30	37.38	44.50
Fine Calcareous Earth,	5.0		85.	28.0	2.002	2.387	2.695	2.695	61.8	2.10	35.63 (96°1F.)	43.00 (109°4F.)
Gypsum,	7.3	100.	27.	71.7	0.077	0.077	0.077	0.077	73.2	2.34	36.25	43.62
Humus	8.7	84.6	190.	20.5	6.160	8.469	8.470	9.240	49.0	1.43	39.75 (103°5F.)	47.37
Sandy Clay,	57.3	94.0	40.	52.0	1.617	2.002	2.156	2.156	76.9	2.41	36.75	44.42
Stiff Clayey Soil,	68.8	91.1	50.	45.7	1.925	2.310	2.618	2.695	71.1	2.30	37.38	44.62
Stiff Clay,	83.3	88.6	70.	34.9	2.310	2.772	3.080	3.157	68.4	2.24	37.25	44.50
Fine Clay,	100.0	81.7		31.9	2.849	3.234	3.696	3.773	66.7	2.19	37.50	45.00
Garden Earth	7.6	85.1	89.	24.3	2.695	3.465	3.850	4.004	64.8	2.16	37.50	45.25
Arable Earth from Hoffwyll,	33.0	88.0	52.	32.0	1.232	1.771	1.771	1.771	70.1	2.27	36.88	44.25
Arable Earth from the Jura,	22.0	90.5	48.	40.1	1.078	1.463	1,540	1,540	74.4	0.36	36.50	43.75
Carbonate of Lime in fine powder,		95.0										

From a careful comparison of these results, the following conclusions, bearing more directly upon the employment of Calcareous manures in agriculture may be drawn:

First: The tenacity of fine calcareous earth is less than one-tenth of that of sandy clay soil, less than one-twelfth of stiff clay soil, less than one-sixteenth of the tenacity of stiff clay, and twenty times less than the tenacity of pure clay.

The tenacity of calcareous earth is less than one-fourth the tenacity of arable land, and approaches more nearly to that of Humus, and of the richest and best garden earth.

In wet weather stiff clay lands, on account of the rapidity and extent with which they absorb, and the obstinacy with which they retain water, are soon converted into a stiff cohesive mud, which is worked with great trouble and difficulty on account of the increased tenacity. In long continued dry weather, stiff clay lands on account of the extent to which they contract and of the consequent increase of their tenacity, not only become so hard that they are with difficulty worked, but the roots of corn and cotton and of all vegetables penetrate the hard dry soil with great difficulty, and are greatly exposed and injured by the shrinking and cracking of the clay during drying. Not only theory and philosophical experiments performed in the Laboratory, but more especially practical agricultural experience, demonstrate in the clearest and most indisputable manner, that the addition of marl and of calcareous manures generally to clay soils, diminishes their tenacity in both wet and dry weather, counteracts the tendency to shrink and crack during dry weather, and thus renders them more easy of cultivation, and more suitable to sustain vegetation.

Second: Inasmuch as calcareous earth absorbs water far more rapidly and to a much greater extent, and retains it much more tenaciously than sandy soils, and than even good arable land, it is evident that the addition of marls and calcareous manures generally to sandy lands will in crease the power of absorbing and of retaining water, and

thus remedy a most prominent and injurious defect in this class of soils. Here again the results of experiment and the deductions of reason, correspond with those of actual agricultural experience.

Third: The Hygrometic power of calcareous earth, is not only far greater than that of sand and sandy soils, but it is nearly twice as great as that of good arable land. The ability to absorb moisture readily from the atmosphere is a most valuable property in its relations to the germination and development of the vegetable kingdom. The moisture in the atmosphere contains not only water, which enters so largely into the composition of all plants, but it also contains small quantities of Carbonic Acid gas, Ammonia, and in certain conditions of the atmosphere, Nitric Acid—compounds which play an essential part in the economy of vegetation. It is evident, therefore, that the addition of marls and of calcareous manures to sandy soils, and in fact to almost all arable lands, will increase their fertility, by increasing their power of absorbing water and valuable compounds from the atmosphere.

Fourth: Calcareous earth absorbs heat less rapidly, and is far less subject to variations of temperature than sandy soils, and in fact, even than good arable soils.

The rapidity with which soils allow their water to evaporate influences their temperature, for during the evaporation of the water the thousand degrees required to change the water to the state of vapor, is abstracted principally from the surface of the soil, upon which the evaporation is taking place. It is evident from this fact that soils which retain their moisture with tenacity, and consequently allow their water to escape by evaporation slowly, and at the same time absorb heat slowly and part with it correspondingly slowly, must necessarily possess a far more uniform temperature, and must as a necessary consequence be far more favorable to vegetation than soils which allow of rapid evaporation, and rapid aborption and radiation of heat.

The addition of marls and of calcareous manures, generally to sandy soils will render their temperature more uniform.

A still farther comparison of the results embodied in the tables of the composition of the soils of various countries and States in Europe and America, leads to the observation that *soils differ greatly in the proportion of organic matters.*

An accurate knowledge of the amounts of organic matter in soils, is essential to the intelligent and successful application of calcaceous manures to land.

The intelligent and successful application of calcaceous manures must depend upon a knowledge of the chemical relations of lime to the inorganic and organic constituents of the soils.

(c) *Chemical Relations of Lime to the Inorganic and Organi Constituents of Soils.*

The effects of lime upon the constituents of soils are not merely physical effects ; as marked and as important as are the physical effects of calcareous manures upon soils, the chemical effects are still more decided and important.

By the following simple experiments, the planter may demonstrate to himself, that lime exerts chemical effects upon manures, soils and rocks.

If lime be mixed with Peruvian Guano there will be produced, almost immediately, a strong smell of Ammonia; the lime has displaced the Ammonia, and combined with the Carbonic Acid and other organic and inorganic acids which had formed with the Ammonia of the Guano, solid compounds; the same effect will be produced by the addition of lime to stable or cow-pen manure. This effect of lime upon the compounds of Ammonia, is exceedingly interesting to the planter, as indicating the impropriety of adding quick lime to manures which contain the valuable ingredient Ammonia.

If we carefully wash out all the soluble matters from manure of any kind, and then add lime, we will obtain, af-

ter allowing the mixture to remain for several hours, an additional amount of soluble matter.

If we place a definite quantity of soil upon a filter, and pass pure water through it until every trace of soluble matter is removed, (which may be determined by evaporating the distilled water after its passage through the soil, in a clear watch glass or silver plate,) and then add to the soil lime, and allow the mixture to remain in a moist state for several days, and again pass distilled water through the mixture, we will obtain an additional portion of soluble matter, together with a portion of the lime which has been rendered soluble by chemical combination with the elements of the soil.

If we boil Felspar, one of the constituents of Granite, which contains the silicates of Potash and Alumina, with water, or even with acids, they will dissolve but little out of it, even after days and weeks; if however, the Felspar be mixed with lime, the alkali Potash may be readily dissolved out by means of acids, and even by water.

These experiments clearly show that when lime is added to the soil it causes chemical changes in both the inorganic and the organic compounds of the soil.

It is important that we should examine more closely the chemical effects of lime upon these two great classes of compounds, which exist in all fertile soils.

(d) *Chemical effects of Lime upon the Inorganic Constituents of Soils.*

Every fertile soil is composed in large measure of insoluble Silicates, which are commonly called clay. The different varieties of clay, although possessing many properties in common, still differ in chemical constitution, and each variety, although apparently nothing but a plastic mass of a homogeneous simple substance, is in reality composed of several different substances. The varieties of clay will differ with the rocks from which they have been derived, and with the various changes through which they have passed. Thus kaolin or china clay may arise from the decomposition of

the same rock Felspar, under two different conditions; and the kaolin will be different in each case. When felspar, which consists of one atom of the silicate of potash, combined with two atoms of silicate of Alumina, decomposes in a wet or rainy atmosphere, the silicate of potash appears to be simply washed away by the water, and the resulting clay has the composition of three atoms of silica and two atoms of alumina; when however, the felspar decomposes in a moist, but drier atmosphere, the silicate of potash, instead of being entirely washed away, is first decomposed, the silicic acid combines with the silicate of alumina, and the potash escapes as a carbonate, and the clay resulting is composed of four atoms of silica and two of alumina.

There are numerous other minerals which, during their decomposition, afford clay of various constitutions.

To illustrate this important truth to the agriculturist, that clays are composed of a great variety of substances, we have selected as examples three specimens of clay, from one country (the Netherlands) taken from the Zuiderzee, and analyzed by E. H. Von Baumhauer.

We shall, at a subsequent part of this report, present analyses of the Joint clays of Georgia, and not only illustrate the propositions here announced, but also demonstrate their great value in agriculture.

TABLE 30. CHEMICAL COMPOSITION OF CLAYS FROM THE ZUIDERZEE.

	First.	Second.	Third.
Insoluble Quartzose sand, with Alumina and Silica,	57.646	51.706	55.372
Soluble Silica,	2.340	2.496	2.286
Alumina,	1.830	2.900	2.888
Peroxide of Iron,	9.039	10.305	11.864
Protoxide of Iron,	0.350	0.563	0.200
Protoxide of Manganese,	0.288	0.354	0.284
Lime,	4.092	5.096	2.480
Magnesia,	0.130	0.140	0.128
Potash,	1.026	1.430	1.521

	First.	Second.	Third.
Soda,	1.972	2.069	1.937
Ammonia,	0.060	0.078	0.075
Phosphoric Acid,	0.466	0.234	0.478
Sulphuric Acid,	0.896	1.104	0.576
Carbonic Acid,	6.085	6.940	4.775
Chlorine,	1.240	1.302	1.418
Humic Acid,	2.798	3.991	3.428
Crenic Acid,	0.771	0.730	0.037
Apocrenic Acid,	0.107	0.160	0.152
Humin, Vegetable remains and Water chemically combined,	3.324	7.700	9.348
Wax and Resin,	trace	trace	trace
Loss,	0.542	0.611	0.753
	100.000	100.000	100.00

We are at once impressed with the important fact that these clays contain all the elements necessary for the growth and development of plants and animals. We shall hereafter show that the Joint clay not only in like manner contains all the elements necessary for the constitution of plants and animals, but also contains a much larger proportion of Phosphoric Acid, than these clays; and has by the abundance of this fertilizing element rendered the soils with which it has been mixed exceedingly fertile and durable, and has through the vegetable kingdom exerted most marked and important influences upon the physical structure of the inhabitants.

Notwithstanding that many clays contain all the inorganic compounds necessary for the production of vegetables, still, in almost every case, these compounds are insoluble, and can be obtained by the plants growing in the soil, only in small quantities.

Carefully conducted experiments have demonstrated conclusively, not only that these inorganic salts are absolutely necessary to the existence of the higher species of plants used by man for food and clothing but also that these salts

to be available to plants must be in a soluble condition. It is evident therefore, that whatever tends to decompose and render soluble the insoluble constituents of clays, will add to the fertility of the soil.

This is precisely the effect accomplished by lime. By its action upon the inorganic constituents of the soil, the insoluble silicates of the clay are decomposed, and alumina and magnesia, and the alkalies, potash and soda, are set free, and silica is rendered soluble.

In adding lime to the insoluble silicates of the soil, the agriculturist acts in precisely the same manner that the chemist does when he wishes to separate the constituents of some insoluble and apparently undecomposable mineral as felspar. In both cases the silica is separated and the alkalies liberated; and it is well known to agriculturists that these alkalies are of the greatest importance in the successful cultivation of corn and cotton, and in fact, of all plants. To substantiate the value of these alkalies combined with silicic acid, we need look no farther than to the valuable effects of the Green Sand of New Jersey, the chemical composition of which we have before given. See page 46, table 12.

(e) *Chemical effects of Lime upon the Organic Constituents of Soils.*

The organic matters existing in the soil have been derived from both the vegetable and the animal kingdoms. It is well known that these two kingdoms are mutually dependent—the vegetable kingdom is a great laboratory, worked by the forces of the sun and fixed stars, in which materials are prepared and elaborated for the animal kingdom; whilst the animal kingdom consumes these materials prepared by plants, and derives from their chemical changes precisely the same amount of force which was expended by the sun and fixed stars in the vegetable laboratory, it does not destroy this matter, but merely changes its form. The vegetable products, the starch, the sugar, and all the various compounds consumed by the animal kingdom, are

converted into various compounds and restored to the soil, and to the atmosphere. The principal portion restored to the atmosphere, the poisonous Carbonic acid gas constitutes an important element of the food of plants—the same is true of the ammonia resulting from the decomposition of the fæces and urine, and bodies of animals. It is admitted that from the atmosphere, Carbonic acid gas, water, ammonia and the inorganic salts, furnished by the animal kingdom, all the various vegetable products may be formed.

The vegetable kingdom in like manner with the animal kingdom, is liable to constant change, generation succeeds generation; and as in the case of animals, the dead are added to the soil and atmosphere. The products of the decomposition of the vegetable kingdom which we call Humus, have all existed in the atmosphere, at some former period in the form of gas, and will exist in some future period again in the atmosphere in the form of gas, and will again be sbsorbed by the vegetable kingdom, and under the influence of the heat and light of the sun these gases will again be decomposed, the elements combined with other elements so as to form solids, destined to go through the same round of changes.

The great fact which we wish, by these well established facts, to illustrate and impress upon the minds of the planters is, that the organic matters of the soil are in a state of change, and that this change is absolutely necessary to the existence of the vegetable and animal kingdoms. If the organic matters of the soil remain unchanged, vegetation would go on consuming the Carbonic acid and Ammonia, and the nitrogen of the atmosphere, and converting the great proportion of the compounds resulting from the action of the vegetable kingdom into insoluble useless forms. Whilst it would be true that the animal kingdom would convert a certain portion of the compounds formed by plants into those gaseous compounds necessary for the existence of the vegetable kingdom, still it is evident that there would be a constant diminution of the matter circula-

ting between the two kingdoms, for every leaf and tree that died would abstract a certain portion of this changing matter, and place it in a state of permanent rest.

Humus then is one of the states through which matter passes during its circulation between the animal and vegetable kingdoms.

The principle of practical importance which we derive from these facts is, that the rapid change of vegetable and animal matters into gaseous products is favorable to the development and perfection of crops.

If wood, leaves and vegetable matters generally be exposed to the action of the air, they gradually undergo decomposition, and various products as humic, ulmic, geic, crenic and aprocenic acids are formed, together with Carbonic acid—that most important gas to plants. The rapidity of the decomposition of the vegetable matters will depend upon the temperature, the moisture of the air, and the thoroughness with which the matters undergoing decomposition are exposed to the action of the oxygen of the atmosphere. When the atmosphere has free access, the oxygen of the air is converted into an equal volume of Carbonic gas, and a large quantity of water is evolved, whilst also a small portion of nitrogen is absorbed, and ammonia, that most valuable food of plants is generated. If on the other hand, the supply of air be cut off and the decomposition of the vegetable matters takes place under water, but a small portion of Carbonic acid will be generated, and the products of the decomposition will be far more insoluble and stable than those resulting from the decomposition of the vegetable matters freely exposed to the atmosphere. The insolubility and indestructibility of the products resulting from the slow changes of wood and vegetable matter in general, in positions where they are in great measure excluded from the action of tne oxygen of the atmosphere, may be readily seen in the varieties of coal, lignite and peat, which exert little or no effect upon plants, unless they be first decomposed by the action of some substance possessing power-

ful chemical affinities and capable of exciting decomposition. Whilst peat in its natural state, on account of its insolubility and its power of resisting chemical change, is comparatively valueless as an application by itself to land, still when mixed with lime, it acts most beneficially not only by the compounds resulting from the decomposition of its organic carbonaceous compounds, but also by the liberation during this decomposition of its inorganic salts.

Insoluble organic compounds analagous to peat and comparatively valuless in themselves, exist in every soil; and the value of the organic matters of soils depends not only upon the quantity, but upon the state in which they exist.

We conclude from these facts that any substance which is capable of exciting chemical changes in the various organic constituents of the soil, will render the soil more fertile by assisting in these changes which result in the formation of gases and soluble compounds, and in the liberation of inorganic salts, which are absolutely necessary to a luxuriant vegetation.

It is evident, therefore, that the effects of lime upon the organic constituents of the soil are as important, if not even more important than upon the inorganic constituents; for it occasions the decomposition of the organic matters, and thus gives rise to the formation of carbonic and nitric acids and ammonia, and at the same time liberates the saline constituents of former vegetation, in states of combination well fitted for assimilation by the growing crop.

In the application of lime to the soil it is important that planters should bear in mind the following principles:

First, As lime promotes the decomposition of the organic matters, they must be carefully supplied to the land under cultivation, yearly, for if they be not, then the land will be exhausted more rapidly than if no lime had been applied.

Second, As the organic matter of the soil is decomposed by the simultaneous action of the lime, atmospheric air and moisture, and as the formation of the nitric acid and ammonia takes place at the expense, in part, of the nitro-

gen of the atmosphere, it is not necessary to add immense quantities of lime to the soil; it is not necessary to incorporate the lime with the soil to a great depth. It would be best to make yearly applications, and apply the lime near the surface.

Third, Lime in the caustic state (quick lime from the kiln) acts more rapidly upon the organic matters than the carbonate of lime, which is the form in which it invariably exists in nature, hence quick lime may be employed in much smaller quantities than marl or shell limestone in its natural state; hence quick lime should not be added to the manure pile, while marl and shell limestone may in many cases be mixed, with beneficial effects, directly with the cow-pen and stable manure; and hence the effects of marl and shell limestone in their natural conditions upon vegetation are slower than that of quick lime.

Fourth: Without a sufficient supply of lime to the soil we can never obtain the full effects of manures.

A still farther examination of the chemical constitution of the soils of various countries establishes the following proposition:

(f) *Soils differ greatly in the proportion of Phosphate of Lime and of Phosphoric Acid, both in their natural and in their cultivated states.*

In the majority of the analyses of American soils, Phosphate of Lime and Phosphorie Acid has not been separated, and in those in which its presence has been indicated it has been in most cases represented simply as a trace.

In almost every American soil yet examined, Phosphate of Lime and Phosphoric Acid are deficient.

Phosphate of Lime and Phosphoric Acid enter into the constitution of all plants and animals, and is absolutely essential to their development and perfection.

Careful experiments in Europe and in this country demonstrate that the Phosphate of Lime is a valuable fertilizer to all lands. The fertility of the lands of England are due in great measure to the extensive employment of marls, rich in the Phosphate of lime; and the most wonderful

effects have been produced upon the exhausted lands of Maryland and Virginia, by the application of marl containing, if not as great an amount of Phosphate of Lime as those of England, still a quantity greater than that contained in a liberal application of the best Phosphatic Guanos.

If we institute a comparison between the amounts of Phosphate of Lime contained in the soils of Europe and America with the amounts of this substance existing in the various marls and shell limestone of Georgia, we will be convinced of the great value of these native deposits.

We will consider the value of Phosphate of Lime more fully under the following division of our subject:

CHAPTER VII.

RELATIONS OF THE SHELL LIMESTONE

AND MARLS OF GEORGIA,

TO PLANTS AND ANIMALS.

CHAPTER VII.

Relations of the Shell Limestone and Marls of Georgia to Plants and Animals.

Lime is indispensable to the healthy constitution of plants and animals.

This proposition will be conclusively demonstrated by the following tables, which will prove of great value to the planter, not merely in their present use, but also as affording important information upon the constitution of the ashes of various plants and animals.

TABLE 31—Showing the proportions of Phosphate of Lime, Phosphate of Magnesia, Carbonate of Lime and Carbonate of Magnesia in various vegetable and animal structures.

NAME OF SUBSTANCE.	NAME OF CHEMIST.	Phosphate of Lime in 100 parts......	Phosphate of Magnesia in 100 parts.	Carbonate of Lime in 100 parts......	Carbonate of Magnesia in 100 parts.
Cotton Wool	Prof. Shepard	25.44	trace	8.87	6.85
Cotton Seed	do do	61.64	....	0.41	0.26
Cotton Stalk	J. L. Smith, M. D.	1.81	.....	25.00	8.00
Cotton Fibre	Dr. Ure	9.00	8.40	10.60	....
Indian Corn	Prof. Shepard	17.17	13.83	2.50	2.16
Sweet Potato	do do	14.57	5.60	5.39	3.80
Clean Rice	do do	76.20	.....	.....	Magnesia.
Rice Flour	do do	54.60	.....	.....	
Rice Straw	do do	2.00	.....	2.00	
Blood of Man	Verdeil	3.55	.....	.....	1.26
do do	do	3.21	.....	.....	0.99
Blood of Dog	do	1.32	.....	.....	9.67
Blood of Ox	do	2.51	.....	.....	0.47
Blood of Sheep	do	2.38	.....	.....	0.30
" do	do	2.68	.....	.....	0.82
Blood of Pig	do	2.88	.....	.....	1.21
do do	do	3.17	.....	.....	0.97
Blood of Calf	do	5.30	.....	.....	1.15
do do	do	4.57	.....	.....	1.19
Bones of Ox	Berzelius	86.00	3.00	6.00	....
do do	Heintz	83.07	2.98	10.07	....
Bones of Sheep	do	84.39	2.15	9.42	....
Bones of Man	do	85.62	1.75	9.06	....
do do	do	85.83	1.74	9.19	....

ANALYSES OF THE ASH OF COTTON, WOOL AND COTTON SEED.*

	Wool.	Seed.
Carbonate of Potassa, (with possible traces of Soda)	44.19	——
Phosphate of Lime, with traces of Magnesia	25.44	61.64
Carbonate of Lime	8.85	0.41
Carbonate of Magnesia	6.87	0.26
Silica	4.12	1.74
Alumina, (probably accidental)	1.40	——
Sulphate of Potassa	2.70	2.55
Chloride of Potassium	——	0 25
Chlorides of Potassium, Magnesium, Sulphate of Lime, Phosphate of Potassa, Oxide of Lime in minute traces, and loss	6.43	——
Phosphate of Potassa, (with traces of Soda)	——	31.51
Carbonate of Potassa, Sulphates of Lime and Magnesia, Alumina and Oxides of Iron and Manganese in traces	——	1.64

Or the composition may be expressed thus:

Phosphoric Acid	12.30	45.35
Lime	17.05	29.79
Magnesia	3.26	——
Potassa	31.09	19.40
Sulphuric Acid	1.22	1.16

From these data Prof. Shepard calculates that for every 10,000 lbs. of Cotton Wool, about 60 lbs. of saline matter would be abstracted, having the following constitution:

Potassa, - - - - - - -	31 pounds.
Lime, - - - - - - - -	17 "
Magnesia, - - - - - - -	3 "
Phosphoric Acid, - - - - -	12 "
Sulphuric Acid, - - - - -	1 "

ANALYSIS OF A COTTON STALK—BY J. LAWRENCE SMITH, M. D.

The ashes of a healthy cotton-stalk, six feet high, and an inch in diameter, at the largest part, with some leaves and empty pods, consists of, in 100 parts:

Lime, - - - - -	30.3
Potash, - - - - -	24.3
Phosphoric Acid, - - - -	9.1
Magnesia, - - - - -	5.8
Oxide of Iron, - - - -	0-4
Sulphuric Acid, - - - -	1.3
Chlorine, - - - - -	0.8
Carbonic Acid, - - - -	27.0
Sand, - - - - -	0.5

ANALYSIS OF THE FIBRE OF SEA ISLAND COTTON, BY DR. URE.

Carbonate of Potash, - -	44.8
Chloride of Potassium, - -	9.9
Sulphate of Potassa, - -	9.3
Phosphate of Lime, - -	9.0
Carbonate of Lime, - -	10.6
Phosphate of Magnesia, - -	8.4
Peroxide of Iron, - - -	3.0
Alumina, a trace, and loss, -	5.0

TABLE 32—SHOWING THE COMPOSITION OF THE ASHES OF WHEAT, ACCORDING TO RECENT ANALYSES.

Plants, or parts of Plants.		Ashes in 100 parts of crop as taken from ground...	Ashes in dry plants when all water is artificially removed	Potash.........	Soda.........	Magnesia.........	Lime,.........	Phosphoric Acid.........	Sulphuric Acid.........	Silica,.........	Peroxide of Iron.........	Chloride of Sodium,.........	Locality of Plant.	Analyst.	Remarks.
Wheat, foreign growth	Grain, red..	....	....	21.87	15.75	9.60	1.93	49.32	0.17	....	1.96	....	Giessen........	Will and Fresenius..	
	Grain, white	....	....	33.84	.....	13.54	3.09	49.21	....	....	0.31	....	do	" "	
		....	....	25.90	0.44	6.27	1.92	60.39	....	3.37	1.33	....	Leipsic........	Schmidt........	This wheat being grown near the sea part of the Potash is substituted by Soda.
		....	....	6.43	27.79	12.98	3.91	46.14	0.27	0.42	0.50	....	Holland........	Bichon........	
		....	....	24.17	10.34	13.57	3.01	45.53	....	1.91	0.52	....	Sulz. Hesse-Cassel ..	Thon........	
		....	....	30.12	.....	16.26	3.00	48.30	1.01	1.31	....	....	Bechelbronn Alsace.	Bouissingault	
		1.55	1.74	32.39	2.32	13.94	3.47	43.47	0.35	3.05	0.97	....	France........	Way and Ogsden....	
		1.50	1.68	30.30	1.00	14.28	3.17	45.80	....	4.48	0.89	....	Odessa........	" "	
		1.7	1.88	35.77	9.06	14.09	2.05	34.44	0.24	4.00	....	....	Adrianople........	" "	Grown in calcareous stone-brash, white calcareous brash and clay.
		1.97	2.19	36.60	0.53	11.12	4.34	41.03	0.18	4.97	1.18	....	Egypt........	" "	
Hopeton Wheat, grown in England.		1.81	2.05	33.15	....	12.71	3.20	47.00	0.24	2.84	0.60	....	Cirencester........	" "	
		1.51	1.69	33.00	2.07	13.99	2.82	46.18	0.48	1.42	....	....	"	" "	
		....	....	....	....	....	....	....	....	....	11.	....	"	" "	Seed of previous y'rs
		1.48	1.70	27.06	4.08	13.57	4.29	41.22	1.91	5.90	1.36	....	"	" "	
		1.56	1.72	32.24	4.06	10.94	2.06	45.73	0.32	2.28	2.04	0.27	Dorset........	" "	Sandy Soil.
		1.63	1.84	29.92	6.08	12.43	1.83	45.30	0.59	4.42	1.76	0.64	"	" "	Calcareous soil.
		1.61	1.81	36.43	4.62	13.26	1.32	39.97	0.15	4.23	....	....	Gloucestershire, ...	" "	Silicious soil*
		1.63	1.81	32.05	3.38	9.32	4.43	47.33	....	3.05	0.35	....	"	" "	Clayey soil.
		1.71	1.94	34.51	1.87	11.69	1.80	43.98	0.21	5.63	0.29	...	"	" "	Sandy soil.
		1.69	1.92	30.32	0.07	12.38	2.51	49.22	0.18	3.60	0.08	1.60	"	" "	Clayey soil.
		1.76	2.01	32.14	2.14	9.67	8.21	44.44	....	3.29	0.08	....	"	" "	Sandy soil.
		1.70	1.91	31.00	2.54	9.53	1.45	40.91	0.08	9.71	3.34	0.34	Sutton Waldron.. ..	" "	Loamy soil.

*Knapp's Chemistry applied to the Arts and Manufactures—vol. 3, p. 81.

TABLE 32—CONTINUED.

Plants, or parts of Plants.	Ashes in 100 parts of crop as taken from grotnd.......	Ashes in dry plants when all water is artificially removed	Potash..........	Soda..........	Magnesia..........	Lime,..........	Phosphoric Acid..........	Sulphuric Acid..........	Silica,..........	Peroxide of Iron..........	Chloride of Sodium..........	Locality of Plant.	Analyst.	Remarks.
Red Straw, white wheat, grown in England.	1.72	1.95	29.75	0.64	13.79	3.27	49.58	0.60	2.14	0.23	....	Gloucestershire, ...	Way and Ogsden.	Sandy Loam.
	1.73	1.97	29.91	1.87	14.05	3.39	47.44	....	2.63	0.57	....	do	do do	do do
	1.61	1.81	30.13	1.25	11.46	6.87	47.38	0.07	2.76	0.07	....	do	do do	Calcareous Soil.
	1.60	1.80	30.02	3.82	13.39	1.15	46.79	....	3.89	0.91	....	do	do do	Clayey Loam.
	1.90	2.13	29.17	2.20	14.22	5.05	46.61	0.44	2.17	0.09	....	do	do do	SandyCalcareous soil
	1.73	1.96	26.70	2.12	12.76	6.78	46.99	0.24	2.05	2.32	....	do	do do	Calcareous Clay.
Old Red Lamas Wheat,	1.84	2.00	34.26	4.53	9.56	3.21	40.57	0.32	5.46	2.06	....	Wantage,..........	do do	do Soil.
Spalding Wheat..	1.81	2.05	29.76	5.26	11.06	2.88	48.21	0.11	2.23	0.23	....	Cirencester,....	do do	do do
Creeping Wheat......	1.73	1.95	31.18	2.42	12.35	1.50	46.49	0.61	5.20	0.22	....	Hackness..........	do do	Clayey Sand.
do do	1.65	1.85	28.89	1 40	13.06	6.76	45.64	1.55	2.55	0.11	....	do	do do	Calcareous
do do	1.71	1.91	30.94	1.28	12.74	3.72	48.53	....	1.34	1.40	....	do	do do	
Mean of the 32 Analyses	1.77	1.93	29.97	3.90	12.30	3.40	46.00	0.33	3.35	0.79	0.09			

TABLE 33—SHOWING THE CHEMICAL COMPOSITION OF THE ASH OF BARLEY, OATS, INDIAN CORN, TEA, COFFEE, TOBACCO, &c.

Plants, or parts of Plants.	Ashes in 100 parts of crop as taken from the ground.	Ashes in artificially dried plants	Potash.	Soda.	Magnesia.	Lime.	Phosphoric Acid.	Sulphuric Acid.	Silica.	Peroxide of Iron.	Chloride of Sodium.	Chloride of Potassium.	Chlorine.	Locality of Plant.	Analyst.
Barley, grain and straw	....	7.15	13.86	.....	3.96	11.81	7.67	4.37	37.27	2.30	1.84	....	....	Oxford	Daubeny.
Grain of	2.04	....	19.1	.....	7.60	3.6	31.2	3.4	33.2	2.30	2.3	....	....	Ensham	do
do	2.37	....	3.91	16.75	10.05	3.36	40.63	0.26	21.99	1.93	....	....	....	Cleves	Bichon.
Grain, without husk	2.5	....	29.50	.....	15.90	2.90	47.0	1.00	1.30	....	....	....	....	France.	Boussingault.
Mean of 10, analysis of barley grain	2.34	2.43	19.77	3.93	8.55	2.58	35.20	1.03	26.49	1.43	0.47	....	....		
Oats, grain	2.75	3.12	13.97	1.50	8.82	4.22	21.53	0.13	49.44	0.36	....	....	....	Cirencester	Way and Ogsden.
Mean of 7, analysis of Oats, grain	2.90	3.02	16.76	2.49	7.70	3.92	18.19	1.29	47.08	0.64	0.20	8.19	....		
Mean of 2, anal. of Oats without husk.	2.18	....	26.18	.....	9.95	5.95	43.84	10.45	2.67	0.40	....	....	....		
Oat-husks	6.49	....	6.99	.....	1.01	4.31	2.65	54.01	74.73	1.61	....	....	....	Scotland	Fromberg.
Mean of 4, analysis of oat-husks	6.79	....	8.13	.....	1.09	3.15	1.54	6.46	76.16	1.33	....	....	....		
Indian Corn	....	....	26.63	7.54	15.44	1.59	39.63	5.54	2.09	0.60	....	....	....	United States.	Fromberg.
do do	....	....	.....	.....	17.0	1.3	50.1	.....	0.8	....	....	....	....	Bechelbronn.	Letellier.
do do mean	....	....	.....	.....	16.22	1.44	44.87	2.77	1.44	0.30	....	....	....		
Rice Grain	....	....	18.48	10.67	11.69	1.27	53.36	.....	3.35	0.45	....	....	....		Johnson.
Rice Husk	....	....	1.60	1.58	1.96	1.01	1.86	0.92	89.71	0.54	....	....	....		Rolich.
Millet Grain	....	....	9.58	1.31	7.66	0.86	18.19	0.35	59.63	0.63	1.43	....	....	Giessen	do
Pea	....	3.18	39.51	3.98	6.43	5.91	34.50	4.91	.....	1.05	3.71	....	....	Vienna	Will and Fresenius
Pea	....	2.79	34.19	12.76	8.60	2.46	34.57	3.56	0.25	0.96	....	....	0.31	Giessen	Bichon.
Sow Bean	....	4.16	20.82	19.06	8.81	7.26	37.94	1.34	2.46	1.03	....	....	1.48	Vienna	do
Bean	....	4.41	38.89	11.78	9.03	5.90	31.34	2.47	0.44	0.11	....	....	0.33	Giessen	Levi.
Lentil	....	2.60	34.31	13.3	2.44	6.24	35.82	....	1.31	1.98	....	....	4.56	do	do

TABLE 33—CONTINUED.

Plants, or parts of Plants.	Ashes in 100 parts of crop as taken from the ground	Ashes in artificially dried Plants	Potash	Soda	Magnesia	Lime	Phosphoric Acid	Sulphuric Acid	Silica	Peroxide of Iron	Chloride of Sodium	Chloride of Potassium	Chlorine	Locality of Plant.	Analyst.
Potato—tubers	....	4.00	59.96	.....	6.28	2.09	13.16	8.27	6.52	0.59	5.20	....	....	France	Boussingault.
do do	....	4.01	57.58	3.66	4.53	0.81	9.98	14.63	3.68	0.42	8.6	....	....	Lanark	Fromberg.
do do	....	3.75	49.73	1.93	5.03	3.31	14.58	18.04	2.49	0.56	7.5	....	....	Drunmore	do
do do	1.27	.....	46.60	.....	8.70	4.54	13.30	4.66	1.95	3.30	3.43	....	....	Oxford	Danberg.
do do	1.08	.....	50.00	0.84	6.85	2.70	16.20	2.37	7.15	5.15	1.95	....	....	do	do
do do	0.76	.....	43.80	.....	12.65	3.10	11.15	6.0	6.67	6.85	2.30	....	....	do	do
Mean of 6 analyses	....	3.92	55.75	1.86	5.28	2.07	12.57	13.64	4.23	0.52	7.01	....	....		
Coffee	....	.....	50.94	14.76	10.10	4.33	13.59	trace.	3.58	0.66	....	....	1.22		Levi.
							Phosphate of Lime.	Sulphate of Lime.							
Tobacco-leaf	....	18.90	28.08	2.26	7.22	27.67	8.78	6.43	17.65	....	0.91	....	....	Debreczen	Will and Fresenius
do do	....	22.20	30.67	.....	8.57	24.79	6.03	5.60	18.39	....	5.95	....	....	do	do do
Mean of 4 analyses	....	21.28	26.46	0.56	9.72	27.87	7.00	7.14	12.13	....	6.91	2.21	....		do do
Tobacco-leaf	....	27.36	11.21	.....	12.77	47.03	6.30	5.11	12.03	....	2.98	2.58	....	Funf kirchen	
do do	....	23.28	9.68	.....	14.58	49.28	5.19	6.68	5.54	....	4.44	4.61	....	do	do do
Mean of 4 analyses	....	23.68	12.14	0.07	13.09	45.90	5.48	6.35	8.01	....	3.49	3.49	....		
							Phosp'ric Acid.	Sulphuric Acid.							
Sugar Cane	....	1.30	27.32	1.03	3.65	9.13	3.75	6.64	45.78	....	....	....	2.70	Trinidad	Stenhouse.
do do	....	1.80	11.99	2.26	9.86	13.17	7.97	10.92	42.81	....	....	....	1.02	do	do
do do	....	1.30	15.00	4.76	4.41	8.73	8.16	4.56	45.51	....	....	....	8.85	do	do
do do	....	2.40	21.39	1.16	6.84	8.96	4.53	10.80	40.80	....	....	....	5.47	do	do
do do	....	3.30	11.87	2.62	15.53	5.75	8.12	7.48	46.24	....	....	....	2.39	Berbice	do
do do	....	.....	13.62	3.37	12.94	5.07	7.53	6.37	49.74	....	....	....	2.36	do	do
do do	....	.....	16.81	5.43	11.78	4.45	4.84	7.67	44.68	....	....	....	4.34	do	do

Table 34.—Proportion of Sulphur and Phosphorous in Plants and Grain, according to H. C. Sorby. Liebig and Kopps, A. R. P. of C. vol. 2. p. 128. Sulphur and Phosphorous in 100 parts of substances, dried at 212°.

	Sulphur	Phosphorous.
Poa palustris and trivialis	0.165	0.164
Lolium perenne	0.310	0.183
Italian Rye Grass	0.329	0.145
Trifolium pratense	0.107	0.149
do do	0.087	0.131
Trifolium repens (very fine kinds)	0.099	0.188
do do (ordinary do)	0.151	0.139
Medicago lupulina (very fine)	0.136	0.052
Medicago Sativa	0.274	0.046
do do	0.452	0.215
do do	0.293	0.358
Vicia Sativa	0.178	0.183
Kidney Potatoes (solanum tuberosum)	0.094	0.213
Tops of Kidney Potatoes	0.389	0.357
Fruit of Kidney Potatoes	0 071	0.597
American Potatoes	0.082	0.212
Tops of American Potatoes	0.206	0.488
Daucus Carota, roots	0.092	0.255
do do tops	0.745	0.382
Beta Altessima, roots	0.058	0.190
do dc tops	0.502	0.293
Brassica Rapa, roots	0.351	0.352
Delta do do	0.421	0.346
do do tops	0.758	0.360
Brassica Oleracca, (Swedish Turnip)	0.435	0.172
do Oleifera, (Rape)	0.448	0.233
Brass. Campestris, (Drumhead Cabbage	0.421	0.267
Wheat Plant entire, (Trit.cum Vulgare, after flowering	0.151	0.248
do do do do	0.170	0.140
Ear of the Wheat when the Grain was formed, but still milky	0.075	0.271
Straw of Wheat when grain was formed	0.240	0.132
Ear of Wheat when ripe	0.090	0.336
Straw of Wheat when ripe	0.213	0.043
Red Wheat	0.070	0.363
Straw of Red Wheat	0.293	0.079
White Wheat	0.054	0.366
Straw of White Wheat	0.207	0.112
Wheat	0.051	0.410
Chaff of Wheat	0.091	0.252
Very fine Barley, (Hordeum distichum)	0.066	0.498
Straw of Barley	0.390	0.087
Poor Barley	0.040	0.367
Straw of poor Barley	0.191	0.065
Barley Plant in flower	0.318	0.236
Oat Plant (Avena Sativa) just flowering	0.226	0.194
Oat Plant in Flower	0.189	0.189
Green Oats	0.125	0.317
Straw of Green Oats	0.329	0.128
Black Tartarian Oats	0.080	0.381
Straw of Black Oats	0.271	0.110
White Oats	0.090	0.334
Straw of White Oats	0.401	0.153
White Oats	0.074	0.382
Straw of White Oats	0.195	0.057
Rye ears (Secale cereale) when young	0.073	0.076
Straw of Rye	0.099	0.153
Rye	0.051	0.160
Bean Plant (vica faba) in flower	0.045	0.258
Beans	0.071	0.600
Straw of Beaus	0.148	0.233
Peas (Pisium sativum	0.158	0.206
Straw of Peas	0.214	0.076
Fine Hops (Humulus Lupulus)	0.127	0.574
Rind of Hops	0.091	0.138

Table 35.—Ash of Yolk and White of Hen's Eggs.—Poleck.*

	Albumen.		Yolk,	
	No. 1	No. 2	No. 1	No. 2
Chloride of Potassium	41.29	42,17	....	....
Chloride of Sodium	9.16	14.07	....	....
Soda	23.04	16.09	5.12	6.57
Potassa	2.36	1.15	8.93	8.05
Lime	1.74	2.79	12.21	13.28
Magnesia	1.60	3.17	2.07	2.11
Sesquioxide of Iron	0.44	0.55	1.45	1.19
Hydrated Phosphoric Acid			....	....
Phosphoric Acid	4.83	3.79	5.72	....
Carbonic Acid	11.60	11.52	63.81	66.70
Sulphuric Acid	2.63	1,32	....	....
Silica	0.49	2.04	0.55	1.40

*Liebig and Kopp's annual report on Chemistry. &c., for 1850, vol. 4, p. 379.

TABLE 36.—ASHES OF MAN AND OTHER ANIMALS—VERDEIL.*

	Dog.		Ox.		Sheep.		Pig.		Calf.		Man.	
	No.1	No.2	No.1	No.2	No.1	No.2	No.1	No.2	No.1	No.2	No.1	No.2
{ Chlorine	30.25	30.94	35.88	32.60	34.66	30.72	25.07	30.05	30.46	36.13	37.50	33.76
{ Sodium	19.60	20.04	23.24	21.11	22.45	19.90	16.24	19.46	19.73	23.40	24.49	21.87
Soda	5.78	2.02	13.00	14.40	13.33	13.40	7.62	5.33	10.39	10.41	2.03	6.27
Potassa	15.16	19.16	5.60	8.76	5.29	7.93	22.21	18.54	11.74	9.81	12.10	11.24
Magnesia	0.67	4.38	0.47	0.59	0.30	0.82	1.21	0.97	1.15	1.19	0.99	1.26
Sulphuric Acid	1.71	1.08	1.25	1.16	1.65	1.91	1.74	1.34	1.34	1.21	1.70	1.64
Phosphoric Acid	12.74	9.34	3.40	3.02	3.83	3.41	10.61	11.48	4.91	3.76	7.48	9.74
{ Phosphoric Acid	1.22	2.35	1.66	1.62	1.38	1.58	1.68	1.27	3.45	2.97	1.87	1.36
{ Lime	0.10	0.70	0.85	0.70	1.00	1.10	1.20	1.90	*1.85	1.60	1.68	1.85
Sesquioxide of Iron	12.75	8.65	9.00	8.80	8.70	9.17	9.10	9.52	3.52	7.80	8.06	8.68
Carbonic Acid	0.52	0.37	6.57	6.49	7.09	6.35	0.69	0.36	3.77	3.57	1.43	0.95

*Annual Chemical Pharmacy lxix, 89. Leibig and Kopp's Annual Report on Chemistry for 1849, vol. 3.

TABLE 37—COMPOSITION OF THE BLOOD OF MAN AND ANIMALS in normal condition, in 100 parts, according to Poggiale.*

	Man...	Man...	Ox.....	Cow....	Calf....	Sheep..	Rabbit.	Dog....	Cat....	Fowl...	Pigeon..
Water	779.9	767.6	796.1	788.2	835.6	798.0	831.0	798.0	812.0	785.0	795.0
Blood Corpuscles	130.1	143.0	123.1	126.2	92.5	102.0	91.5	126.0	109.2	150.3	143.1
Albumen	77.4	74.0	65.5	67.2	55.3	85.0	63.8	63.0	64.1	47.2	48.1
Fibrin	2.1	2.3	5.4	6.3	4.1	3.2	3.2	2.2	2.2	5.1	5.1
Fatty Matters	1.1	1.3	2.2	2.2	1.3	1.8	1.6	2.3	2.1	2.3	1.7
Extractive Matters and Salts	9.3	11.8	8.7	10.0	11.2	10.0	8.9	8.5	10.3	9.1	8.9
The Salts contain—											
Chloride of Potassium and Sodium	4.7	6.4	4.7	4.8	6.1	5.7	4.6	4.4	5.6	5.0	5.4
Chloride of Calcium	....	....	0.2	0.2	0.3	0.2	0.3	0.2	0.3	0.1	0.2
Phosphate of Soda	1.4	1.7	0.8	0.8	1.1	1.0	0.8	0.8	0.9	0.8	0.8
Sulphate of Soda	0.4	0.4	0.6	0.3	0.8	0.6	0.6	0.5	0.7	0.4	0.3
Carbonate of Potassa and Soda	0.5	0.6	0.4	0.9	0.4	0.3	0.4	0.3	0.5	0.4	0.2
Phosphate of Lime	0.7	0.7	0.5	1.0	0.8	0.7	0.5	0.5	0.7	1.2	1.1
Sesquioxide of Iron	1.3	1.5	1.3	1.4	1.1	1.1	1.0	1.5	1.2	0.8	0.6
Carbonate and Sulphate of Lime	0.3	0.4	0.2	0.4	0.3	0.2	0.3	0.1	0.2	0.3	0.2
Loss	0.1	0.2	0.2	0.2	0.3	0.2	0.4	0.1	0.2	0.2	0.2

*Annual report of the Progress of Chemistry, by Liebig and Kopp, vol. 2, 1847, 1848, p. 154.

TABLE 38.—ASH OF BLOOD, according to Henneberg, 100 parts contain.

	Blood of Fowls	Blood of Turkey.		Blood of Fowls	Blood of Turkey.
Chloride of Potassium,	29.14	36.81	Phosphate of Soda and Potassa	19.63	20.24
Chloride of Sodium	16.87	3.31	Phosphates of Lime, Magnesia and Iron.	6.99	8.49
Soda	21.04	24.02	Sulphuric Acid	1.19	0.97
Sesquioxide of Iron	3.89	4.77			
Lime	1.03	0.93			
Magnesia	0.22	0.46			

*Liebig and Kopp's annual report on Chemistry, vol. 2, p. 159.

Table 39.—Ash of Blood, according to Enderlin. In 100 parts of Ash.

	Goose....	Goose....	Young Cock.	Young Cock.	Young Cock.	Young Cock.	Young Cock.	Young Cock.	Pigeon...	Pigeon...	Pigeon...	Duck....	Frog....	Frog....	Perch....
Phosphate of Iron......	9.61	11.07	8.15	7.95	8.45	8.70	7.5	7.6	9.4	10.0	9.8	10.0	9.61	10.5	9.5
Phosphate of Lime......	9.34	12.54	} 9.63	} 13.26	{14.79	{14.50	{15.0	{15.2	13.2	12.1	13.4	17.3	13.5	7.9	9.5
Phosphate of Magnesia..	6.04	8.47													
Phosphate of Potassa....	26.24	18.57	36.38	18.36	52.34	50.48	25.0	24.4	20.4	39.5	34.9	28.0	....	....	36.0
Phosphate of Soda......	6.18	20.68	3.17	7.19	....	....	....	....	26.4	37.9	31.3	17.1	38.5	40.4	....
Sulphate of Potassa...	2.34	0.65	....	3.30	....	....	....	....	1.9	....	....	4.0	1.6	1.7	....
Chloride of Sodium....	39.84	27.20	40.13	46.56	20.89	23.57	37.9	38.4	28.6	....	7.5	21.6	31.8	39.3	43.4
Silicate of Soda......	...	....	2.98	....	....	....	....	....	....	....	....	....	....	....	....
Silicate of Potassa......	....	....	....	....	3.53	2.75	14.6	14.4	....	....	...	....	....	....	....
Ash in 100 parts......	1.22	1.28	1.23	1.13	....	....	....	....	1.20	1.29	1.55	1.05	0.84	....	1.11

*Loc. Cit., vol. 2, pp. 159—160.

The results embodied in these tables, not only sustain the proposition that lime is indispensable to all highly organized plants and animals, but they also establish numerous conclusions and principles of the greatest value to the agriculturist. We shall at present notice only those which have an immediate connexion with the commercial and agricultural relations of the tertiary lime formation of Georgia.

(*a*). The proportion of lime varies in different plants and animals.

(*b*). The proportion of lime varies in different parts of the same plant or animal.

It follows from these two propositions: First, different crops abstract different quantities of lime from the soil, and if these crops be sent off the plantation, the loss of lime to the place will depend not merely upon the amount, but also upon the character of the produce.

Second, if animals be raised for market, the amount of lime abstracted from the soil through the vegetable kingdom, will depend upon the mode in which they are prepared for the market. If they be driven off in the living condition, all the lime which they have abstracted from the soil will be lost to the place. If they be killed upon the place, quite a large proportion of the valuable salts which

they have abstracted from the soil will be restored in the form of blood. If they be consumed upon the place, the greatest proportion of the lime which they have abstracted from the soil will be found in the bones.

Third, as animals, whether carnivorous, herbivorous, or graminivorous, subsist ultimately upon the vegetable kingdom; and as the salts which they derive from the soil through the vegetable kingdom, are thrown off in the urine and fæces, it is evident that the lime will be transported in the bodies of the animals from one part of the place to the other, and will accumulate principally at the stables, cow-pens, and the habitations of man.

(*c*). The proportion of phosphoric acid and of phosphate of lime, varies in different plants and animals, and also varies in different parts of the same plant or animal; and hence different crops and animals abstract different quantities of phosphorous and phosphate of lime from the soil.

(*d*). Lime and phosphoric acid, although entering largely into the composition of plants and animals, are by no means the only inorganic elements necessary for the development and preservation of the animal and vegetable kingdoms. The salts of soda, potassa, magnesia and iron are equally essential to the perfection of plants and animals, and, as in the case of lime and phosphoric acid, they vary in amount in different plants and animals, and in different parts of the same plant or animal; and hence different crops and animals abstract different quantities of these salts from the soil.

(*e*). The quantity and character of the inorganic salts, although varying within certain limits, are still remarkably uniform in the same class of plants and animals. We have selected in these tables, to demonstrate this important agricultural fact (that each class of plants and animals must have a definite amount of inorganic salts of a definite constitution), numerous analyses of the same plant by different observers.

It follows from this that the farmer can calculate not only the amounts, but also the character of the salts annually removed from his lands.

Thus in the following crops the amounts of ash in the right hand column would be removed from each acre producing the amount of produce to the acre, assumed in the table:

TABLE 40.

	Weight of crop per acre in lbs.		Ashes per acre in lbs.
	As gathered.	Dried at 212°.	
Indian Corn—Grain	2250.	2000.	12.
" Stalks, leaves and fodder	9000.	8000.	288.
Wheat—Grain	1000.	900.	18.
" Straw	2000.	1900.	76.
Rye—Grain	1450.	1300.	29.
" Straw	4500.	4300.	236.
Oats—Grain	2200.	2000.	64.
" Straw	3500.	3200.	241.
Tobacco—Leaves	800.	750.	108.
" Stalks	600.	550.	50.
Red Clover—Hay	3000.	2700.	236.
Timothy—Hay	3000.	2700.	153.
Potatoes—Tubers	9600.	3000.	124.
" Tops	3000.	1000.	150.

TABLE 41.—Table illustrating the proportions of the various inorganic matters, abstracted from the soil by 1,000 pounds of various kinds of produce.

NAME OF CROP.	Potash	Soda	Lime	Magnesia	Alumina	Oxide of Iron	Oxide of Manganese	Silica	Sulphuric Acid	Phosphoric Acid	Chlorine	Total a'mt of Ash
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Ash of Wheat—Grain	2.25	2.40	0.96	0.90	0.26	....	....	4.00	0.50	0.40	0.10	11.77
" " Straw	0.20	0.29	2.40	0.32	0.90	....	....	28.70	0.37	1.50	0.30	35.18
Ash of Barley—Grain	2.78	2.90	1.06	1.80	0.25	trace	....	11.82	0.59	2.10	0.19	23.49
" " Straw	1.80	0.48	5.54	0.76	1.46	0.14	0.20	38.56	1.18	1.60	0.70	52.42
Ash of Oats—Grain	1.50	1.32	0.86	6.67	0.14	0.40	....	19.76	0.35	0.70	0.10	28.80
" " Straw	8.70	0.02	1.52	0.22	0.06	0.02	0.02	45.88	0.79	0.12	0.05	57.40
Ash of Rye—Grain	5.32	....	1.22	1.78	0.24	0.42	0.34	1.64	0.23	0.46	0.09	10.40
" " Straw	0.32	0.11	1.78	0.12	0.25	....	....	22.97	1.70	0.51	0.17	27.93
Ash of Beans—Seed	4.15	8.16	1.65	1.58	0.34	....	....	1.26	0.89	2.92	0.41	21.36
" " Straw	16.56	0.50	6.24	2.09	0.10	0.07	0.05	2.20	0.34	2.26	0.80	31.21
Ash of Field Pea—Seed	8.10	7.39	0.58	1.36	0.20	0.10	....	4.10	0.53	1.90	0.38	24.64
" " " Straw	2.35	....	27.30	3.42	0.60	0.20	0.07	9.96	3.37	2.40	0.04	49.71
Ash of Vetch—Seed	9.97	6.22	1.60	1.42	0.22	0.09	0.05	2.00	0.50	1.40	0.43	22.90
" " Straw	18.10	0.52	19.55	3.24	0.15	0.09	0.08	4.42	1.22	2.80	0.84	51.01
Ash of Turnip—Roots	2.386	1.04	0.75	0.25	0.03	0.03	....	0.38	0.80	0.89	0.28	6.303
" " Leaves	3.23	2.22	6.20	0.59	0.03	0.17	....	1.28	2.52	0.98	0.87	18.09
Carrot—Roots	3.53	0.92	0.65	0.38	0.039	0.03	0.06	0.13	0.27	0.51	0.07	6.619
Parsnip	2.07	0.72	0.46	0.27	0.024	0.005	....	0.16	0.19	0.10	0.17	4.180
Potato Roots	4.02	2.33	0.33	0.32	0.050	0.03	....	0.08	0.54	0.40	0.16	8.283
" Tops	8.19	0.09	12.97	1.70	0.04	0.02	....	4.94	0.42	1.97	0.50	30.89
Rye Grass Hay	8.81	3.94	7.34	0.90	0.31	....	....	27.72	3.53	0.25	0.06	52.86
Red Clover	19.95	5.29	27.80	3.33	0.14	....	....	3.61	4.47	6.51	3.62	74.78
White Clover	31.05	5.79	23.48	3.05	1.90	0.63	....	14.73	3.53	5.05	2.11	91.32
Lucerne	13.40	6.15	48.31	3.48	0.30	0.30	....	3.30	4.04	13.07	3.18	95.53
Sainfoin	20.57	4.37	21.95	2.88	0.66	....	....	5.00	3.41	9.16	1.57	69.57
Indian Corn	2.087	....	0.97	0.57	......	....	....	....	....	1.88	....	....
Cotton Wool	3.10	....	....	1.70	0.30	....	....	....	0.10	1.20	....	....

These tables illustrate in a forcible manner, the exhausting effects of crops, and demonstrate that, whenever the vegetation in any form whatever, as grain, or hay, or fruit, or timber, is removed from the soil the land is gradually impoverished, by the removal of those salts which are necessary to the fertility of the soil.

The great question with the planter is, how can this drain be stopped, and from whence can materials be obtained which will restore to the soil these salts which are carried off in every pound of cotton, and corn and beef.

The preservation of the soil permanently in a state of the highest fertility, is the great problem to be settled by the Southern Agriculturist.

Up to the present time, the Planters of Georgia have attempted no solution of the problem, but have cleared tract after tract of virgin soil, abandoned the worn out lands as soon as they proved unprofitable, and pursued their course of reckless devastation and exhaustion of one of the finest countries in the world, until nothing but furrowed, washed gullied and barren red clay hills, and barren sandy plains are left to the present generation.

The great question of the regeneration of the worn out lands will find its solution in the proper use of the Tertiary Lime formation of Georgia, and of the natural sources of organic matters so abundant in our State.

If we institute a comparison between the amounts of Lime and Phosphoric Acid abstracted by the various crops from each acre of land and the amounts of lime and of Phosphoric Acid contained in a moderate application of the marls and shell limestones of Georgia, we will find that a single application is capable of supplying Lime and Phosphoric Acid equal to the amount removed by the most productive crops of cotton, corn, wheat, rye, oats, potatoes, beans and peas for more than one hundred years.

This demonstration of the value of the marls and shell limestone of Georgia should, we think, lead to their immediate and extensive employment.

We do not for oue moment contend that the Tertiary Lime formation of Georgia contains all the ingredients necessary for the entire restoration and preservation of the fertility of the soil.

Whilst Lime should in Georgia, as it does in England, and in every well cultivated country in the world, form the basis of all permanent agricultural improvement and of all husbandry, still it represents only one class of the salts needed by plants and animals, and if, therefore, it be exclusively relied upon disappointment will surely follow, sooner or later.

This leads us to the consideration of the following well established proposition:

The absence from the soil of any one of the constituents of the Ash of Plants, will prove adverse to vegetation.

The Prince of Salm-Horstmar performed a series of careful synthetic experiments to determine which of the ash constituents are necessary to the growth of plants. He chose for his experiment the oat plant, sowed the grains in an artificial soil of ignited sugar-charcoal, watered it with distilled water, and supplied the ash constituents by means of the following preparations, which were partly dissolved in the water and partly incorporated in the sugar-charcoal: Silicate of Potassa and Soda, Carbonate, Phosphate and Sulphate of Lime, the Salts of Magnesia, Sesquioxide of Iron, oontaining Protoxide, with and without Manganese, Sulphate of Protoxide of Iron, Carbonate of Manganese, Carbonate of Ammonia, Nitrate of Lime, Magnesia, and Ammonia. By modifying the experiment in various ways, omitting one, and sometimes all of these preparations—adding them at one time in increasing proportions, and at other times in decreasing quantities, and in each instance accurately observing the growth, appearance and character of the plants thus cultivated, Salm-Horstmar arrived at the following results: without the addition of any of the above mentioned Salts the plants remained dwarfish, but without any abnormal development. For the successful growth of

plants Nitrogen (Ammonia) and the vegetable Ash, constituents must be added at the same time. Absence of the one, especially of the latter, enfeebles the action of the lat ter. In the absence of Phosphoric Acid, Sulphuric Acid, Potassa, Lime, Iron and Manganese, the plants in every instance, attained an abnormal growth, were feeble and of unnatural softness, and rapidly faded away; they were particularly weak when no Silicic Acid and Magnesia were present. Iron acted most surprisingly upon the luxurious and vigorous appearance, especially in regard to the color, strength of stem and roundness; but when an excess was added it produced dry spots on the plants. Too large a proportion of Manganese caused the leaves to curl up in a peculiar manner. Without weakening the plants, neither the Potassa could be replaced by Soda, nor the Lime by Magnesia.

In the whole of these experiments the plants were placed in abnormal circumstances, and only in one single instance (and in that only a single grain was produced) did they yield corn.

It is evident, therefore, that my duties as Chemist to the Cotton Planters' Convention do not end with the development of the inexhaustible stores of fertility in the Tertiary Lime formations of Georgia—other sources of fertility supplying the salts wanting in the Marls and Shell Limestone of Georgia must be supplied.

Before, however, we proceed to present the results of our investigations upon other sources of fertility, we desire to substantiate our statements, by the results of the experience of others, for enlightened experience is the great excitor and leader of intelligent action. The list of authorities might be greatly extended, but we believe that these will serve our present purpose.

CHAPTER VIII.

ANCIENT AND MODERN TESTIMONY,

TO THE

VALUE OF LIME IN AGRICULTURE

CHAPTER VIII.

Ancient and Modern Testimony to the value of Lime in Agriculture.

In China, the country which probably more than any other country, owes its internal wealth and extensive population to thrifty and skillful agriculture, the beneficial effects of Lime have been known from ancient times.

In this country, where every practicable spot is under a high state of cultivation, and where two, three and four crops are obtained in the year from the same ground, not only is manure of every kind carefully preserved and applied to the land, but is also extensively mixed with pounded shells, and hundreds of boats are employed in dredging for Fossil Shells in the beds of these rivers, to supply the wants of agriculturists.

The following quotations from the great work of the learned Pliny,* published A. D. 77, will show that the ancients were acquainted with the use of marl long before the Christian era:

"There is another mothod which has been invented, both in Gaul and Britain, of enriching earth by the agency of itself, being that kind known as marl. This soil is looked upon as containing a greater amount of fecandating principles, and acts as a fat in relation to the earth, just as we find glands existing in the body, which are formed by a condensation of the fatty particles in so many kernels. This mode of proceeding, too, has not been overlooked by the Greeks; indeed, what subject is there that they have not touched upon? They call by the name of leucargillon a white argillaceous earth, which is used in the territory of Megara, but only where the soil is of a moist, cold nature. It is only right that I

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* The Natural History of Pliny, translated with copious notes and illustrations, by the late John Bostock, M. D. F. R. S., and H. T Riley, Esq., B. A., London. H. G. Bohn, 1855, vol. iii, Book xvii, chap. 4, pp. 452—455.

should employ some degree of care and exactness in treating of this marl, which tends so greatly to enrich the soil of the Gallic provinces and the British Islands. There were formerly but two varieties known, but more recently with the progress of agricultural knowledge. several others have begun to be employed; there being, in fact, the white, the red, the columbine, the argillaceous, the tufaceous, and the sandy marls. It has also one of these two peculiarities: it is either rough or greasy to the touch; the proper mode of testing it being by the hand. Its uses too are of a two-fold nature—it is employed for the production of the cereals only, or else for the enrichment of pasture land as well. The tufaceous kind is nutrimental to grain, and so is the white; if found in the vicinity of springs, it is fertile to an immeasurable extent; but if it is rough to the touch, when laid upon the hand in too large a quantity, it is apt to burn the soil. The next kind is the red marl, known as acaunumarga, consisting of stones, mingled with a thin sandy earth. These stones are broken upon the land itself, and it is with considerable difficulty during the earlier years that the stalk of corn is cut, in consequence of the presence of these stones; however, as it is remarkably light, it only costs for carriage one-half of the outlay required in using the other varieties. It is laid very thinly on the surface, and it is generally thought that it is mixed with salt. Both of these varieties, when once laid on the land, will fertilize it for fifty years, whether for grain or for hay.

Of the marls that are found to be of an unctuous nature, the best is the white. There are several varieties of it; the most pungent and biting being the one already mentioned. Another kind is the white chalk that is used in cleaning silver; it is taken from a considerable depth in the ground, the pits baing sunk in most instances as much as one hundred feet. These pits are narrow at the mouth, but the shafts enlarge very considerably in the interior, as is the case in mines; it is in Britain more particularly that this chalk is employed. The good effects are found to last full eighty years; and there is no instance known of an agriculturist laying it twice on the same land during his life. A third variety of white marl is known as glisomarga; it consists of fullers chalk, mixed with an unctuous earth, and it is better for promoting the growth of hay than grain; so much so, in fact, that between harvest and the ensuing seed time there is cut a most abundant crop of grass While the corn is growing, however, it will allow no other plant to grow there. Its effects will last so long as thirty years; but if laid too thickly on the ground, it is apt to choke up the soil, just as if it had been covered with Signine cement. The Gauls give to the Columbine marl in their language the name eglecopala; it is taken up in solid blocks like stone, after which it is so loosened by the action of the sun and frost, as to split into laminae of extreme thinness; this kind is equally beneficial for grass and grain. The sandy marl is employed if there is no other at hand, and on moist slimy soils, even when other kinds can be procured.

The Ubii are the only people that we know of who, having an extremely fertile soil to cultivate, employ methods of enriching it; wherever the land may happen to be, they dig to a depth of three feet, and, taking up the earth, cover the soil with it in other places a foot in thickness; this method, however. to be beneficial, requires to be renewed at the end of every ten years. The Ædui and the Pictones have rendered their lands remarkably fertile by the aid of limestone, which is also found to be particularly beneficial to the olive and the vine.

Every marl, however, requires to be laid on the land immediately after ploughing, in order that the soil may at once imbibe its properties; while at the same time it requires a little manure as well, as it is apt, at first, to be of too acrid a nature, at least when it is not pasture land that it is laid upon; in addition to which, by its very freshness, it may possibly injure the soil, whatever the nature of it may be; so much so, indeed, that the land is never fertile the first year after it has been employed.

It is a matter of consideration also for what kind of soil the marl is required; if the soi is moist, a dry marl is best suited for it; and if dry, a rich unctuous marl. If, on the other hand, the land is of a medium quality, chalk or columbine marl is the best suited for it."

Dr. Morton,* in his valuable work upon the Nature and Properties of Soils, thus testifies to the part which lime has played in British husbandry:

"Lime has long been applied by British husbandmen as a stimulus to the soil; and in consequence of such an application, luxuriant crops have been produced, even upon soils of apparently inferior quality, and which would have yielded crops of trifling value, had this auxiliary been withheld.

In fact, the majority of soils cannot be cultivated with advantage until they are dressed with lime; and whether considered as an antidote, or a stimulant, or as a manure, it will be found to be the basis of good husbandry, and of more use than all other manures put together.

Wherever lime has been properly applied, it has constantly been found to prove as much superior to dung, as dung is to the rakings of the woods, or the produce of a peat mire."

The following is the testimony of Mr. Edmund Ruffin, of Virginia, whose agricultural writings have accomplished incalculable benefits to his native State, in leading to the intelligent and extensive use of calcareous manures. In his able "report of the commencement and progress of the agricultural survey of South Carolina," Mr. Ruffin thus testifies to the results achieved by marling:

"The benefit, or increased product of crops, to be expected from proper applications of marl, if estimated by the numerous and known and unquestioned facts of results in Virginia, may be expected to range (according as circumstances may be more or less favorable to the action), from 20 to 50 per cent. increase on the first crop; and to increase thereafter in each successive crop, until a permanent maximum product is reached of 100 to 300 per cent. upon the product previous to marling. And the increased products would be much larger at first, and also in after time (as is the case in Virginia,) but for the general plan of continual and exhausting tillage in South Carolina. The improvement is permanent, so made. Whatever is thus gained, will never be lost under a proper course of culture, and that not required to be more mild than due considerations of profit ought to dictate under any circumstances. And though additional dressings of marl or lime will be needed in after time, it will not be because any of the early effect of the prior application has been lost, or is even diminished, but because another and new increase of production may be then added to the first.

But all my arguments for and exhortations to commence and prosecute heartily this greatest and most profitable mode of fertilization, avail nothing as yet in the minds of most persons, because of their unbelief of the promised effects as to their own lands and to South Carolina. And this is not merely the result of ignorance on the subject (which always is incredulous,) but has better or more plausible grounds, in the facts that most of the few trials of marl which have been made in the State, have been reported to produce either very little effect the first year, or none at all. Perhaps if made acquainted with all the facts and circumstances of each such case of reported failure, partial or total, I might be able to explain the causes. But though I have done this, and even to the satisfaction of the unsuccessful and before despairing experimenter, in many particular cases, it is obvious that all the facts cannot be generally obtained; and if they were, that this report cannot offer a place for such extended comments on such trivial matters. But it is not necessary for me to contest any such asserted failures. I may go farther, and admit (as is believed, indeed, to be the fact,)

* Morton on the Nature and Properties of Soils, London, 1838, p. 182.

that before the beginning of 1843 there was but one person in the State who had found enough benefit in his first year's marling to proceed forthwith boldly and with increased confidence. zeal and energy on the second year. And this distinguished exception of very large operations (Gov. Hammond's, now extended to 1200 acres,) commenced no farther back than for the crop of 1842; and the increased products, even in this case, though fully satisfactory to the proprietor, were not half equal to what would have been realized on land in proper condition to receive calcareous manures.

Further, of the numerous experiments made this year, after the commencement of my duties. and in consequence of them, of the greater number whose results I have heard, the benefits have been either very small, or, as reported in some cases, not even perceptible. Can the opponents of marling desire more full admissions than these? And yet they all serve but to illustrate what I have continually striven to impress, that without vegetable matter to combine with, calcareous manures will be of but little value.

But, on the other hand, I have heard of no trial of marl on land in proper condition, that is recently and sufficiently rested, and thereby provided with vegetable matter, in which the effect has not been very great in the first crop. And three or four such results only would be enough to prevent all inferences unfavorable to marling, if from a hundred failures of early effort under reverse circumstances. I will cite a few of such experiments.

John A. Ramsey, Esq., on Ashley river, like many other persons, has this year marled land long under incessant annual tillage, and with but little benefit to this year's crop. But he also tried a marked space on land recently cleared, and which had produced but one crop, in 1842. The marling was too light. Still he believed the increase on the marled space to be at least 100 per cent.; and so it appeared to me, when seeing the land as late as November 25th, long after all the cotton had been gathered and the stalks dead. The other result is even more striking, because more accurately observed.

Henry Davis, Esq., on Peedee, applied last spring to a marled acre, also of new ground of the second year, 300 bushels of marl containing 60 per cent. of carbonate of lime. At my request, he carefully weighed the product separately, and also that of an adjoining acre, equal to the other but for the difference of marling. The season was very unfavorable and the whole crop of cotton bad. The product of the marled acre was 592 lbs. of seed cotton, and of the unmarled 336 lbs. These rates of increase are such as I have been accustomed to obtain on lands having sufficient previous rest, and receiving for manure all their growth, and that only while at rest. The application of marl or lime to alluvial rice lands, I had early and earnestly recommended, though on theoretical grounds alone, having then no knowledge of any actual application.

J. M. Dwight, Esq., upon that advice, applied marl last spring to a small marked portion of his newly embanked rice ground on Ashley river. In addition to hearing the remarkable benefit stated by several persons, I recently saw the remaining stubble of the crop. Never was superiority of growth more manifest. But it should be admitted that the great benefit of this marling seemed to consist in resisting the evil action of salt in the land which greatly injured, and in parts totally destroyed the rice elsewhere. Previously, I had gathered information of several different applications of lime to rice lands; one only recently, which produced great effect on the first crop—and the other applications of ancient date, some of them made by accident; but all producing good and long continued effects. Col. Pinckney Allston told me of two spots in rice fields near Georgetown, on which the lime used for indigo oats had been thrown (as was inferred,) on which he has always seen a remarkable superiority in the growth of rice, and which continues undiminished. As indigo culture ceased on these lands at least 60 years ago, this chance-made liming must be at least 60 years old; and probably the land has produced a rice crop every year since, and certainly without any other manure.

When estimating the profits of application of putrescent manures of very quick and transitory effect (as cotton seed, for example,) the increased and early products ought to return both the principal and interest of the outlay, as well as a fair profit thereon, or the planter will have gained nothing by the investment or application. But in calculating the profits of marling and liming, the increased

PREFACE.

0 for the purpose of presenting the fullest proof, in facts and
derived from the experience of practical men, of the operation
:ts of marl, I published sundry circular queries, and also directed
ecially to many known individuals. The general and blameable
ss in this respect which marks the whole agricultural class, and
llingness to write any facts for publication, prevented my ob-
ınswers from more, including myself as one of the number, than
ng farmers. Than these, no others would have been better wit-
r their respectability, and their opportunities of judging, so far
experience and observations extended back. But there were
ıy others who failed to answer, who had either longer or larger
ce of marling. or who had obtained more important benefits
a, than the greater number whose answers were given, and
ıswers, even if standing alone, offer such full and conclusive
the certain effects and great profits of marling.
uch more extended answers of these twenty-two individuals, as
e published in the Farmer's Register, for the more important
their testimony, will be here condensed in the following tabular
which some general statements and remarks will be added. The
t blank in the table, were either not answered at all, because of
ıty, or so generally, and in such extended terms as not to permit
ıught into this congested and concise form.
roper to state, in advance, that though the system of cropping
all these lands before marling was more or less exhausting, still
ome degree of rest from tillage crops, was universal. And that
ling, as required by the known necessity for such procedure, the
culture was always made more lenient, and grazing was gener-
idden, in part, or wholly, during the intervening years of rest
ɔping. The most general rotation of the country, and of most
persons, previous to marling, was the "threeshift" with grazing:
rst year, Corn; second, Oats, or Wheat in part, where the land
oo poor for either, and grazing after harvest; and third, close
of the natural growth of grass and weeds. This exhausting
was generally and immediately changed after marling, by the
ohibition of grazing; and afterwards partially or wholly, by
Clover as a manure crop, in the year of rest. In a few other
milder four-shift rotation was used, which merely had another
st added to the above; and in fewer cases, and but in part, this
ır-shift, in which a second crop of Wheat was taken, instead of
d year of rest and Clover, or three grain crops and one of Clover,
grain crops and one of Clover (as manure) in four years.
ıld also be stated, that it was an error with most of these per-
rith most others, to marl too heavily. Some of them, in this
njured more or less land, perhaps all in Prince George county.
erally more nett profit would have been derived from lighter
ons.
: The woodland remaining to be cleared, and such as was by
rings added to these farms was nearly all poor, and if not
fter a few crops being taken, would have been poorer than the
average of older land. And for this reason, very few, if any,
w clearings taken throughout, would have served without be-
d, to increase the former general average product per acre.
ıd Wheat have been the sole great market crops of these lands,
xception of Cotton for a few years only, and which crop is now
l.

C

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NO.	P.
	Prince
1	James B.
2	John B. I
3	Edw. A. M
4	John H. M
5	H. H. Cock.
6	Elgin Russe
7	Theodrick
8	Edmund W
9	Wm. Wilk
10	Red. M. Ha
11	Coggins' P
	King W
12	Wm. S. Fc
13	Thomas Rob
14	Thomas Car
	Surr
15	Bolling Jones
16	Wm. C. Joı
17	P. T. Spratı
	James C
18	H. B. M. Ricl
	Pamunkey Ri *green-sa*
19	Wm. F. Wi
20	Edmund F.
21	Corbin Braxt
22	Carter Braxt

products being permanent, the average annual returns should be counted, but as the interest and profit of the principal thus permanently invested. Hence, while cotton seed as manure (supposed not generally to act longer than the first year,) to be really profitable, ought to yield, in the first crop, at least 110 or 120 per cent. on the total cost of the manuring, and stable manure at least 70 per cent., a greater profit would be reaped from marl or lime, were the first or even the average annual increased nett products only 12 or 15 per cent. on the first total cost. And when instead of such small increase there is found, as most commonly after a few years, a permanent increase of 100 or 200 per cent. on the previous product, and perhaps 50 or 100 per cent. on the entire cost of the manuring, the superiority of returns over those of all putrescent and transient manures, used alone, is so great as almost to forbid comparison. Considering, then, the increased nett and average annual products from marling and liming, as permanent interest or profit upon the cost of the manuring (if accomplished by a course of judicious general culture and management,) it is for each planter to estimate and compare his probable returns with the necessary expense of his particular outlay. The gross returns from the application of calcareous manures may not vary greatly, and, indeed, will be very regular and uniform under equal circumstances. But the expenses will be very different, according to the difference of easy or difficult access to the manure. Very many planters in this State, and upon a very extended field of operations, may marl so cheaply that their clear profits therefrom may be more than 100 per cent. per annum on the outlay for all future time. And if content with as little as 12 per cent. of permanent nett annual interest (which is, perhaps, double the interest of their agricultural capital in general,) there are very few planters in South Carolina so remote from marl or lime, that they may not resort to this mode of improvement."—Report of the Agricultural Survey of South Carolina, by Edmund Ruffin, 1843, pp. 54–56.

Statements of the most extensive (and also continuing) Marling operations in South Carolina, by John S. Palmer and Gov. J. S. Hammond, of South Carolina. From the Southern Agriculturist.

TO THE AGRICULTURAL SOCIETY OF ST. JOHNS BERKLEY.

Gentlemen: I have been urged by Mr. Ruffin, who lately visited our neighborhood, to lay before you the result of our experiments and progress in the use of Marl.

It may not be in our power to submit such exact statements as would be desirable on a subject of so much importance, yet, if we can show you that so far as we have tried the system, it is not only practicable, but highly satisfactory, we trust it will be an inducement to many who are now hesitating, to commence forthwith, and satisfy themselves by actual experiment.

Dr. Robert Gourdin (whose plantation at Lenud's Ferry, lies partly in Georgeton and partly in Williamsburgh District.) has been good enough to furnish me with the following statement: A field of 50 acres of flat sour pine land, which had been belted in 1838, and roughly listed is 1839, was prepared for planting in 1840, by changing the course of the beds across. Upon this new list, he brought Marl one mile and a half, and applied it at the rate of one hundred bushels to the acre—excepting six acres running the whole length of the field, one half an acre in width. No memorandum was kept this year of the field and no difference was perceptible in the growth or product of the cotton. In 1841, it was again planted in cotton. Throughout the whole of the season the marled looked decidedly superior to the unmarled. An accurate account was kept of the respective portions of the field.

The marled produced an average of one hundred and twenty-eight pounds of clean cotton to the acre, the unmarled but sixty-three. In 1842, no account was kept of the difference of product—but so manifest was the advantage of the marled over the unmarled, that it was a matter of serious regret that the actual difference could not have been ascertained. Dr. Gourdin has no doubt that the marled portion was considerable better than the year previous.

He is so well convinced of the benefit to be derived from Marl that he has applied it to twenty acres more this year, and contemplates a more extensive use of it hereafter.

My brother (Col. Samuel J. Palmer,) commenced in 1839 to marl—on a

field of 24 acres which had been cleared five years previous, and the preceeding year had rested—after listing in the weeds, he applied Marl at the rate of 100 bushels to the acre. One portion of the field was a flat whitish clay soil, the remainder what may be termed a free, open soil, and more elevated. In 1836 this field had been planted in cotton, and produced 140 pounds clean cotton to the acre. In 1837, in oats, which although not measured, yet the general appearance of the crop did not promise exceeding 10 bushels to the acre. It was then thrown out to rest as before observed. The product of this field in 1839 was 270 pounds clean cotton to the acre—and exceded the general average of the whole crop. In 1840 it was assisted with trash and leaves under the list. The June freshet destroyed the whole of the first planting—it was replanted on the 15th of the same month; no account was kept of its product this year; but as far as could be judged by the eye, it did as well as any other part of the field which had not been drowned. In 1841 it was again planted in cotton, and produced 220 pounds to the acre. It was unquestionably the best field of cotton on the place. In 1842 it was planted in oats, eleven acres were reserved for seed, and yielded, when thrashed, upwards of twenty bushels to the acre. The color and character of the clay land which was marled has materially changed, and no one who remembers its appearance in 1833 will doubt the efficacy of Marl. My brother has now one hundred and five acres marled, sixty of which was applied this year.

I proceed now to give you the result of my own experience in the use of Marl, but regret that no account was ever kept of the difference between the products of the marled and unmarled fields. In September, 1838, I commenced digging it out. In two wet days, with all my hands employed, I had about 2500 bushels heaped ready to be hauled out the winter following. This, however, was the only occasion on which I got out the material before the carts were ready to take it to the field.

It is a saving of time to apportion only so many diggers and loaders to each cart as will, taking into consideration the distance and roads to the field, keep the work steadily and regularly progressing. In 1839 I applied Marl on about 50 acres of land, at various rates. From 80 to 100 bushels was the usual quantity, but in some spots as much as 150 bushels were tried. Thirty-six acres had been in cotton the year before and fourteen in oats. The marl on these 36 acres was applied under the list, and I could discover no advantage this year from it. The season was one of the most propitious for cotton, and as such will be long remembered throughout this country. The fourteen acres which had been in oats, and where the weeds and stubble had been listed the autumn preceeding, showed an improvement the first year that the Marl was applied. It was land which must originally have been of the best quality, but had been sadly scourged by hard cropping before I got possession of the place. In 1840 it was planted in oats, and exhibited a most striking contrast to the crop which was on it 1838. In 1841 it was again planted in cotton, and it was fifty per cent better than it ever was. The last year I planted it in oats, and on such parts where hitherto the crop would be supposed good for 10 to 15 bushels to the acre, I am confident from 20 to 25 bushels were made. The growth of crab grass and weeds which succeeded the oats induce me to believe that this land will do better another year than a great deal of much fresher that has not yet had the benefit of the Marl. In 1842 the 36 acres which had not since 1839 exhibited any material change, was planted in cotton after oats. The crab grass was so fine that I was induced to cut a large quantity for fodder before it was listed.

This field, from the lightness of the soil on some parts of it, I feared much would disappoint me in 1842, besides except the occasional rest it had when planted in oats, it had been in cultivation for seven years consecutively. On some of the thinest land compost manure from the cowpen was scattered, and if any doubt had existed previously of the capacity of Marl to fix other manures in the soil, the growth and product of the cotton on these spots would have entirely dissipated them from my mind. On one half acre. selected on account of its unproductiveness previously, about 100 bushels had been applied in 1839, the quantity visibly mixed up with the sandy soil I apprehended would have proven injurious, but the beautiful growth and early maturation of the cotton

on this spot last year, induces me to think we do not apply half enough in general to our land.

Last year I applied from 120 to 200 bushels to the acre on all the land marled but being satisfied with the gradual, but certain improvement, which a moderate quantity will effect, I have the present season fixed as a rule, to give to every acre 120 bushels and no more.

From the frequent interruptions from freshets, I have failed this year in marling as much as I intended, and have in all now little more then 100 acres. If I had no other evidence of the good effect of calcaceous manures than what has been accidently furnished on my place, that alone would be conclusive.

In clearing some fields six or seven years ago, I found some spots heavily coated with lime, thrown out from the pits made no doubt forty or fifty years ago by the old indigo planters.

I was not surprised at first to see the cotton or other crop growing luxuriously on these places, but up to the last season I cannot perceive any falling off in fertility. The long period which has elapsed since the lime was thrown out, must have given time to the soil to accumulate a large quantity of fertilizing matter and the probability is, that its character is permanently established.

These facts are cheering, and we may flatter ourselves that a new era has commenced in the agricultural improvement of every section of State within the reach of Marl. In the course of a few years, we may look to see Marl made an article of natural commerce, and those who are now afraid to carry it 100 yards upon their own soil may, when they shall have covered every foot of arable land in their possession, be found supplying it at a profitable rate to their neighbors, five miles distant. It is to be hoped that a fair trial will be given to Marl by many of the members of this Association, and that our next meeting will furnish abvndant testimony from all quarters on this subject.

N. B.—The Marl used in our neighborhood contains from 90 to 95 per cent. Carbonate Lime, as ascertained by analysis.

JOHN S. PALMER.

[From the Farmers Register.]

COLUMBIA, S. C. Nov. 30 1842.

DEAR SIR.—It affords me great pleasure to comply with your request, to furnish you with a statement of my marling operations during the first year, and the result of them, so far as it has been ascertained.

I commenced in November last to marl my plantation, at Silver Bluff, on Savannah river. There is no marl on my place. I procured it from Shell Bluff on the same river, and had to boat it twelve miles up the stream. It required eleven prime hands to man the boat I used, and when the river is not too high they make two trips a week, loading and unloading themselves. They bring about eleven hundred bushels at a load. The Marl is landed at a spot below high water mark, and during the whole crop season two other hands and two carts are constantly engaged in hauling it to a place of security on the top of the bluff. At other times it is hauled directly from the landing to the fields. There are, however, thirteen hands and two mules lost to the crop. My boat which is a common pole boat, was built chiefly by my own people, and cost me about $600, including their labor. There have been incidental expenses to the amount of about $200 this year. During the year, ending on the 8th of November, there were 85 trips made and about 93.000 bushels brought up. I think I can safely calculate on bringing up 100,000 bushels per annum hereafter with the same force. I mention these facts that every one may form his own estimate of of the cost of procuring Marl under similar circumstances. My calculation is that it costs me about two cents a bushel delivered on my bluff.

To one having Marl on his own premises, nearly the whole of this expense would be saved. I am enabled by omitting to open new land, to haul out and spread this Marl without interferring with other plantation work or lessening the number of acres planted per hand. In hauling out I have not been able to do as much as they do in Virginia. Mr. Ruffin, the author of the marling system, hauled 24 loads of five and-three-quarter bushels with each cart per day, a distance of 847 yards; I have done but little over half as well. I use mules, however, and the land being level, carried six and-a-quarter bushels at a load—I

found the mules could not stand trotting back with the empty cart. The Marl weighs about one hundred and five pounds per bushels. My land was laid off in squares, so many to an acre, and a load dropped in each square. It was spread by hand, each negro taking his square, and carrying his Marl on a board or in a small tray. A prime hand can spread an acre in a day. But it is a hard task, and counting the gang round, I have not averaged over half an acre for each worker. The Marl spreads best when damp. It will then yield to the hand, and the lumps are; in general. easily crushed.

Shell Bluff is a bold cliff, on Savannah River, over two hundred feet high, and in some places more than one hundred feet perpendicular. Prof. Vanuxem, who examined it some years ago, (see Farmer's Register, vol. 7, p. 70, and also vol. 10, p. 487,) discovered fourteen varieties of Marl, varying in quality from 37.2 to 93.4 per cent. of Carbonate of Lime.

In using the Marl I have excluded the inferior as much as possible, and have not found the vrry best in any great quantity. I tested the quantity of Carbonate ot Lime in one specimen taken at random from each boat load brought up this summer, and found the average of thirty-four loads to be 62.8 per cent., varying from 51 to 77. In every specimen there was a small proportion of Oxide of Iron, and clay and sand, usually in about equal quantities. There were no doubt other component parts which I did not ascertain, but I satisfied myself that there was neither gypsum or Magnesia. The Marl presents various appearances, being in color, white, brown, olive, yellow and violet, and in consistence from sand to soft stone. Some of it appears to be a concretion of shells, from a size scarcely visible to the naked eye to an inch in diameter. There is no hard limestone, and it is doubtful whether any of the Marl here will make lime, though it is an excellent cement. Much of that which I have used has been cut from the cliff with pick axes. It falls down sometimes in fine grains, sometimes in masses. At every handling it breaks up finer and exposure to the air assists disintegration. I do not burn or pound it. Where it was spread last winter, an observer would readily discover it, and lumps as large as an egg, and occasionally much larger, are to be seen. A mere passer by, however, would not notice that the land had been marled. At every working it is more and more mixed with the soil. But I imagine it will be several years before it is completely combined with it, and until then the full effects of the Marl cannot be known. A difference was apparent in this crop, between the effects of that spread early in February and that spread in April.

By the 22d of April last I had marled 175 acres, at the rate of two hundred bushels to the acre. Of these I planted fifty acres in corn on the 17th of March, fifty acres in cotton on the tenth of April, and 75 acres in cotton on the 22d of April. These three cuts are in the same field and adjoining, being separated only by turn-rows, yet the soil varies considerably. In the corn I laid off four separate acres, along the turn-row, as nearly equal in quality as possible. The one supposed to be the best was left without marl. The others were marled with one, two and three hundred bushels respectively. It was all of the same boat load and contained 54 per cent. of Carbonate of Lime. This land has been in cultivation more than one hundred years. I have planted it myself eleven of the last twelve years, and sowed it in oats the other year. I have given it three light coats of manure, the last in 1839. It is a light gray sandy soil, of which the following was the analysis before marling, viz.:

Water lost at three hundred degrees,.................	2	per	cent.
Vegetable Matter,..................................	3	"	"
Silica,..	80	"	"
Alumina,..	11	"	"
Oxide of Iron,......................................	2	"	"
Loss,..	2	"	"
	100		

This cut was in cotton last year, and my expectation was that with common seasons it would produce twelve bushels of corn per acre; and had I not kept the unmarled acres as a test, I should have set down all over that quanity to the credit of the marl. The corn came up badly and suffered from the birds. The four experimental acres were cultivated precisely as the rest of the cut, and were

distinguished only by the posts which marked the corner of each aere. From the first, however, the marled corn exhibited a different appearance. It was stouter and of much deeper color. As the season advanced the difference became greater. The marled corn was of as dark a green as swamp corn usually is. The fodder was pulled on the 3d of August, and after hanging two days and a half on the stalk, in dry and rather windy weather weighed as follows:

		Increase.	Per Cent.
Unmarled acre,	250 pounds,		
Marled at 100 bushels,	285 "	35 pounds,	14.
" " 200 "	314 "	64 "	25.6
" " 300 "	261 "	11 "	4,4

The corn was gathered on the 24th of October, being thoroughly dry and having shrunk as much as it would in the field. There appeared to be little or no difference in point of soundness. It was shucked clean and measured in a barrel. The unmarled corn shucked out two quarts less to the barrel than the marled. The following was the result:

	Increase.	Per Cent.
Unmarled acre,............17 bushels,		
Marled at 100 bushels....21 "	4.	23.5
" " 200 "......21 "	4.	23.5
" " 300 "......18 1-2 "	1 1-2	8.8

From this it would appear that one hundred bushels of Marl as efficacious as two hundred, and perhaps in like land such may be the fact. It appears also that three hundred bushels to the acre is too much. I ought. however, to state that this last acre had a slight sink in the centre, and that the slopes around it are much thinner than the average land. These constitute about one-fifth of the acre and were evidently injured by the Marl. It was a bad selection for the heaviest marling, but I did not suppose, judging by the rates at which they marled in Virginia, that three hundred bushels would injure any land. My fear now is that two hundred bushels may prove too much for soil like this, and I have accordingly determined to put only one hundred and fifty bushels on the acre hereafter. until I see its further effects. This has been a remarkably productive season for corn. I think the unmarled acre in the cut made at least five bushels more than it would have done in an average year. I presume the marled acres have done so likewise. But whether it would be fair to attribute any of the four bushels increase to the peculiarity of the season acting on the Marl, I am wholly unable to decide. Supposing the increase from the season to be the same on the marled and unmarled land, and deducting five bushels from the produce of each acre, there will be 33 1-3 per cent. in favor of the two best marled acres. This, however, is all conjecture. The average per acre of this whole cut was eighteen bushels. The measurement of all but the experimental acres was made, however, by wagon loads, according to the usual plantation estimates, in which there is a liberal allowance for shrinking, &c. Had the whole been measured in the same manner as the experimental acres were, the produce would have appeared greater. I have had this cut planted in corn once before, but having been absent the whole year, no account of it was preserved, and I do not know what it produced.

I selected also and laid off separately four acres of cotton along the turn row of the 75 acre cut of cotton. At the time I thought them nearly equal in quality and the one supposed to be the best was left unmarled, and one, two and three hundred bushels of Marl spread upon the other three. It turned out, however, that the acre with one hundred bushels was inferior to the average of the cut, and that with the two hundred bushels about equal to the average, while the other two were far superior. I was deceived by the stalks grown the year before. The two first named acres being somewhat rolling, and the year a wet one, they produced as good cotton as the other two which were flat. The unmarled acre was not much, if at all, superior to the one marled with three hundred bushels, save that there was a spot where the fodder stacks had stood in 1838–'39 which produced nearly double the cotton of any other spot of the same size in either acre, and added probably thirty pounds to the amount gathered from that acre.

The Marl on these acres contained. like that on the corn cut, an average of 54 per cent. of Carbonate of Lime. This land is of the kind commonly known as mulatto soil, and was cleared at least as early as the corn cut. It was certainly planted by the Indians in 1740. The following was the analysis of it before marling, for which, as well as for the analysis of the corn cut, I am indebted to the kindness of Prof. Ellet; ·

Water at three hundred degrees,...........................	3.
Vegetable Matter,..	4.5
Silica..	74.
Alumina,...	14.5
Oxide of Iron,..	4.
	100

This cut was not planted until the 22d of April because it could not be marled before. A dry spell occurring immediately after, at the end of two weeks very little cotton had come up, except in the unmarled acre, in which there was about half an acre. My overseer becoming alarmed in my absence, replanted the whole and threw out the old seed wherever it had not come up. This was done on the 6th of May, so that the crop of this cut dates from this period, which is at least a month later than I should have preferred. For my experience is that early cotton like early corn, is always the best. I consider the two weeks start which one half of the unmarled acre obtained in this instance as of considerable consequence to it. These early stalks could be distinguished until the bolls began to open. The difference in color between the marled and the unmarled cotton was as obvious as it was in the corn. The leaf too appeared broader and the stalk stouter from the first. The following was the production of these four acres. I state the production of all, though that of the one and two .undred bushels ought not to be compared with that of the other two, on account of the relative inferiority of the soil.

The Unmarled acre,................................	1,111 pounds in the seed.
Marled acre at 100 bushels,........................	846 pounds in the seed.
Marled acre at 200 bushels,........................	1,003 pounds in the seed.
Marled acre at 300 bushels,........................	1,318 pounds in the seed,

The difference between the unmarled acre and that with 300 bushels of Marl was 17.7 per cent. in favor of the latter. It would have been greater perhaps any other year than this, which has been almost as favorable for cotton as for corn. The average production of the whole 75 acres was 966 pounds per acre. I have had this cut in cotton ten of the last twelve years, in corn one and oats one, and the following is a statement of its production of cotton for six of the ten years—that of the other years not having been preserved.

1833,	average	per acre	in seed,..................	731 pounds manured lightly.
1844,	"	"	"	784 pounds manured lightly.
1885,	"	"	"	980 pounds manured lightly.
1836.	"	"	"	951 pounns manured lightly.
1840,	"	"	"	497 pounds manured lightly·
1841,	"	"	"	501 manurned.
1842,	"	"	"	966 marled.

The other fifty acre cut of marled land was planted in cotton on the 10th of April. It came up in good time and was a fine stand. This is also a light gray soil, with less clay than the mulatto land, and less sand than the corn cut. It is probably as old as either and has been cultivated in much the same way. Although planted ten days later than some other fields, and after all of them except the 75 acre cut, it soon appeared to be the oldest cotton, and certainly matured the earliest of any of them. Immediately after the cold weather, and about the first of August, the rust commenced in it and by the 20th of that month it had the appearance of a field after frost. Forms, small bolls, and even some of the leaves dropped off. Most persons who saw it thought it had been cut off one half. I think myself it suffered to the extent of one-fourth at least. But I have made on this cut this year 840 pounds of seed cotton which is nearly 50

per cent. more than I ever made on it before. The following is the average of ts production for four years:
1833, average per acre in seed,........................569 pounds manured.
1834, average per acre in seed,..................435 pounds manured.
1840, average per acre in seed,..................368 pounds manured.
1841, average per acre in seed,..................566 pounds manured lightly.
1842, average per acre in seed,..................840 pounds marled.

I think the injury from the rust nearly or quite equal to the benefit derived from the favorable season, and that the increase from the Marl was greater on this cut than any other, because the earliest marled and most seasonably planted. The rust here was more injurious than in any other field, and I might have attributed it to the marling, but that the 75 acre cut, also marled, suffered least of all. I am inclined to think that the most advanced cotton was most affected, and the youngest least, and that the Marl had no influence one way or the other, and it is worthy of remark that while all my other cotton suffered from lice and the worm both, neither made their appearance on the marled land.

I have troubled you with this lengthy detail of my operations because this being the first serious experiment with Marl in South Carolina, [that I know of] it may be interesting to those who have this earth within their reach to know the particulars. From the facts I have stated, each one can form his opinion on nearly as good data as I can my own. I can only add that my expectations for the first year have been fully answered. I did not calculate on any of those magical results which agricultural experimenters so often look for and so seldom realize to the full extent. I regard an increase of 20 per cent. as a very handsome return, and if it only does as well another year I shall at all events, be paid for my labor, even if the beneficial effects of the Marl ceases then. But the experience of all who have used it is, that it continues to improve the soil every year, until thoroughly disintegrated and combined with it: and that with proper culture it never declines from its maximum. Under these circumstances and with these hopes, I shall continue myself to prosecute the business vigorously. During the summer I have hauled Marl over 160 acres, and have now at my landing enough to cover 300 acres more. My great regret is that I did not engage in the business sooner. I have long known of Shell Bluff and for some years have heard of Mr. Ruffin's successful introduction of Marl into the culture of Virginia, but I had not read his "Essay on Calcareous Manures," nor examined Shell Bluff until the summer of 1841. The idea of obtaining Marl from that spot was first suggested to me by my friend, Maj. Dickinson, of Georgia, and after a careful perusal of Mr. Ruffin's Essay and Analysis of the Marls there, I determined to try the experiment. I have during the course of it received much encouragement and valuable practical information from Mr. Ruffin himself, to whom, in common with all other beneficiaries of this inestimable treasure, I owe a debt of gratitude which cannot be easily cancelled.

I am, my dear sir, with regard and esteem your obedient service,

I. H. HAMMOND.

Hon. Whitmarsh Seabrook, President of the State Agricultural Society.

Columbia, November 27, 1843.

Dear Sir.—In fulfillment of my promise made last November, I again communicate to you the result of my experiment in Marling. The year has been so unfavorable to cotton and my crop has fallen so far below the promise of July, that if I had not left some unmarled acres for a test, I should, as no doubt has often been done in other experiments, have come to the conclusion that all my labor had been in vain, and that in fact the Marl had seriously injured my land. The truth, however, is very far to the contrary, and I now think that but for the Marl I should have made no crop at all.

I planted this year seven hundred acres of marled land, of which five hundred and eighty were in cotton, the remainder in pindars and potatoes, of which no accurate account has been kept. The cotton turned out about as much per acre in the whole as the average of the same land for the last ten crops. But believing this year to have been 20 per cent. more unfavorable than an average one, I attri-

bute that much increase on the whole crop to the effect of the Marl.

In my last communication I stated that I had selected four acres of good mulatto land and four others of very light sandy soil, one acre of which in each selection was left unmarled, and the others marled with one, two and three hundred bushels respectively. For the purpose of showing the difference between the most favorable and the most unfavorable seasons I have known for cotton, as well as to indicate the progressive comparative influence of the Marl, I subjoin the result of the last as well as the present year on these experimental acres:

EXPERIMENT NO. 1—MULATTO LAND, 1842.

	Seed Cotton.	Decrease.	Increase.	Per Cent.
Unmarled acre,..................	1,111 pounds,			
Marled at 100 bushels per ucre,...	846 pounds,	265 pounds,		22.8
" 200 " "	1,003 "	108 "		9.7
" 300 " "	1,318 "		207 pounds	17.7

SAME LAND, 1843.

	Seed Cotton.	Increase.	Per Cent.
Unmarled acre,........................	493 pounds,		
Marled at 100 bushels per acre,...........	654 "	161 pounds,	32.6
" 200 " "	759 "	266 "	53.9
" 300 " "	841 "	348 "	70.

As I remarked last year, the acres with one and two hundred bushels of Marl are decidedly inferior in quality to the other two. The unmarled acre and that wlth 300 bushels are as nearly equal as any two on my plantation. It is hardly necessary to say that these acres, lying side by side, were all planted on the same day and cultivated in precisely the same manner. The experimental acres of the thin light land were planted last year in corn. All the marled acres produced better than the unmarled, but I will not repeat this statement, as it does not afford an accurate comparison with the cotton crop of this year, of which the following is the result:

EXPERIMENT No. 2—*Very Light Sandy Soil*, 1843.

	Seed Cotton.	Increase.	Decrease.	Per cent.
Unmarled acre............	361 lbs.	....	....	....
100 bushels do............	451 "	90 lbs.	....	24.9
200 bushels do............	384 "	23 "	....	6.3
300 bushels do............	173 "	....	188 lbs.	52.

The land being very old, is bare of vegetable matter for marl to act on, to which more than to the texture of the soil, inferior as it is, I attribute the failure of any great improvement from it. I make the statement, however, because it is valuable in many respects. It shows the danger of heavy marling on worn land without previous rest or manure. The acre with 300 bushels has been destroyed. There is one rich spot, the bottom of a small basin in the centre of it, which produced nearly all the cotton gathered. On the rest of it the weed mostly died as soon as it came up. 100 proves a better quantity than 200 bushels, and perhaps a little less would have been still better on this soil, at least to begin with. All the lightest land in the fields marled with 200 bushels was evidently injured and now requires help. I anticipated this effect from what I saw last year, and reduced the quantity to 150 bushels on all the land then marling. I have reduced it now to 100 bushels, and shall hereafter marl at that rate. I prefer to go over it again after I have finished all, and give it what it may prove itself able to bear after resting once or twice.

The crop of this year has satisfied me perfectly that cotton will mature at least a fortnight earlier on marled than on unmarled land.

Another unexpected effect of marl it may be worth while to state. I commenced in the spring of 1842 to put it in my stable pretty freely, for the purpose of improving the manure. I did not think of its having any material effect on the health

of the mules. But I have had but little sickness among them, and have not lost one since, while previously I lost on an average four annually, and never in any year less than two. I attribute this change in a great measure to the absorption of noxious gases by the marl.

I am now marling as actively as heretofore, and I esteem it so beneficial that I have this summer marled a field of over 200 acres, the average haul to which is three miles to my landing; and being tolerably fresh land, that has rested this year, and was sowed in oats last year, which were not cut, but grazed down after ripening, I have put a hundred and fifty bushels.

The fields on which my experimental acres are will rest next year. I shall not, therefore, be able to continue my report to you. Since, however, the valuable labors of Mr. Ruffin in this State have given a decided impulse to marling, I presume that all who are within reach of marl will at least experiment for themselves, and it will be of no consequence that I should longer communicate my experience.

I am, very truly and respectfully, your obedient servant,

Hon. Whitemarsh B. Seabrook. J. H. HAMMOND.

Prize Report of Experiments submitted to the State Agricultural Society of South Carolina, Nov., 1844, by Francis S. Holmes, of South Carolina.

Springfield, St. Andrews's Parish, Nov. 19, 1844.

My Dear Sir: Your letter of the 5th instant, with the request to communicate for public advantage the results of my marl experiments the past year, with my general views; also, as to the mode of applying marl, its action on soils, and general utility, I have not been able to answer before. My excuse for the delay is, I am a candidate for the Ruffin premium offered by the State Agricultural Society; and a statement of the experiments to be forwarded to their meeting, which will shortly take place at Columbia, had not been completed until to-day.

As you are, I believe, a delegate to that meeting, I have concluded to send you the statement, with such additions as your letter calls for, and with the request that you will lay the same before the Society.

In all agricultural experiments, accuracy is the first and great requisite, in order to arrive at a true and correct decision; and though the experimenter be satisfied with the effect visible to the eye alone, the actual weight or measure, when brought in comparison, is the true test of its worth. In all my experiments, I have striven to be very accurate and precise, as it is of the utmost importance *to me* to be certain of the effects of this fertilizer. I need scarcely now tell you that my experiments have been so decidedly favorable to marling, that I am of opinion it will, in the course of a very few years, be generally used throughout our State. It will be the means of resuscitating and bringing into cultivation the thousand of old worn out fields, which are every where to be met with. So firmly am I convinced of its utility, that I have opened a pit seventy feet long, by twenty feet wide; undergone considerable labor in removing the soil, which was from 4 1-3 feet to 7 in depth, before reaching the marl, and this for the most part a stiff clay, mixed with rocks, etc.—very hard to dig, and much more so to get clear from the spades and shovels.

I shall continue marling yearly, until every field which I cultivate receives a good dressing.

Many planters urge as an objection, the destruction of the old bed preparatory to broad-casting the marl, it being detrimental to the cotton crop of the next year. But I see no objection to spreading the marl in the alleys, and giving it but half the quantity the first year, and repeating the dressing the next year. This I have determined to do with my cotton fields in future, but with the corn and potatoes I shall continue the broad-casting of the marl.

Very respectfully, your obedient servant,

FRANCIS S. HOLMES.

Robt. W. Roper, Esq.

P. S. I have a statement of an experiment in baliing and pumping water from the marl pit, and also of a successful experiment of one acre of marled corn, close planted—Georgia red flint seed—which produced over 74 bushels, but have not time to send it. It was planted as a prize acre, and not included in my other experiments, therefore not necessary to be sent with them.

EXPERIMENT A.—COTTON.

	Quantity	Manures.	Product.
1	1-4 acre	Natural soil without marl or manure,	43 1-2 lbs. cot. in seed.
2	1-4 "	33 bushels of marl, 66 per cwt. carbonate of lime,	68 " " "
3	1-4 "	4 cart loads, and 33 bushels of marl, all broadcast,	131 1-2 " " "
4	1-4 "	11 cart loads salt marsh mud and 16 bushels of marl under list............	142 " " "

EXPERIMENT B.—COTTON.

1	1-2 acre.	Natural soil, no marl or manure..........	157 1-2 lbs. cotton in seed
2	1-2 "	66 bushels of marl, broadcast....	178 " " "

EXPERIMENT C.—CORN.

	Quantity.	Manures.	Product.
1	1-2 acre.	Natural soil, without marl or manure....	8 1-2 bbls ear corn.
2	1-2 "	8 cart loads of compost in 1843, for corn........	10 1-2 " " "
3	1-2 "	66 bushels marl, broad-cast.............	11 1-4 " " "

EXPERIMENT D.—POTATOES.

Quantity.	Manures.	Product.	
3 rows, 105 feet each in length	Cowpenned........	6 1-4 bushels	1
3 " " " " "	Cowpenned and 33 bushels marl per 1-4 acre......................	5 3-4 "	2
3 " " " " "	8 cart loads compost, per 1-4 acre..	3 1-8 "	3
3 " " " " "	8 " " " and 33 bushels marl, per 1-4 acre..............	4 "	4
3 " " " " "	Natural soil, without marl or manure	1 1-8 "	5
3 " " " " "	33 bushels marl per 1-4 acre	2 1-2 "	6

A.—COTTON.

Experiment A, Nos. 1, 2, 3 and 4. The field in which this experiment was made, has been at rest for some fifteen or twenty years, perhaps prior to 1842; at this time it was covered with a stunted growth of broom grass, and interspersed with a few loblolly or short leaf pines, and small live oaks. It was cut down, the broom grass burnt off, and a part of the field listed, bedded and planted in slip-potatoes, in June, which yielded a fair crop; the balance of the field or hill was not planted (although listed) until the following year, 1843, when the whole field was planted in cotton, and the result was a lost crop. The cotton began to rust in May, and by the middie of August the plants were black and leafless, except in a few spots near the stumps of the oak trees. It did not average 10 lbs. of cotton per acre, nor grow higher than 12 or 14 inches. No manure was applied to any part of this crop, and no difference was perceptible between the part planted in slips, and that not planted the previous year. The soil of this hill is a good sandy loam, but abounding in what we of the low country call iron ore. It is in small particles, and looks like rusted clay. Such soils are very common in this part of

the State. The entire field was listed, or rather levelled (except 1-4 acre No. 4), on March 9th, 1844; this was done with the hoe, and immediately afterward carted and spread broad-cast, 24 cart loads of marl per acre. The carts are drawn by one mule each, and carry 5 to 6 bushels, which gives an average of 5 1-2 bushels for every load, or 133 bushels per acre. Omitting, of course, No. 1, and carting but 16 bushels to No. 4, which had the 11 cart loads of salt marsh mud previously spread in the alleys, and upon this mud the marl was also spread and then immediately listed upon. It was all bedded April 2d, and planted in cotton (fine sea island) on the 4th. The following remarks are taken from my plantation book, and were made at the times noted.

May 12th. Great difference in favor of the marled cotton generally, which can be distinguished to the row—it is taller and more healthy. The season is very dry, and all the crops are suffering much, but the marled land less than the unmarled. June 3d.—In company with two friends (planters), examined the entire crop, and their opinion that the marled crop in every instance is at least 30 per cent superior to the unmarled. June 7th—Blossoms in No. 3, experiment A. 11th—Still very dry; the unmarled one-quarter acre, No. 1, is suffering very much; looks yellow and sickly. July 4th—Accompanied by two other friends, examined the crop, and found the marled cotton far in advance of the unmarled. The marled cotton is green and healthy, and the unmarled quite yellow and sickly. and is not by one-third the height of the former. August 2d—Picked the first boll of cotton from No. 4. August 15th—Began to pick cotton generally from the whole field, but there is very little open in No. 1. Sept. 17th—The one-quarter acre No. 1 appears to be perfectly dead. The other portions of the field are also casting their leaves, and looking like winter, but Nos. 3 and 4 less so than the others. There is a good bloom in the whole field (except No. 1, from which all that could open has been picked), but the plant appears to have made its last effort, and opened the pods up to the top. Picked through this field, which is the last that will be gotten from it. October 7th—Picked in the few remnant pods from experiment A.

Experiment B—Cotton.

Experiment B, Nos. 1 and 2, was made on land that has been under continued cultivation, to my knowledge eight years, and from what I can learn, has been planted nearly every year in the last sixteen or eighteen. I have planted it four successive years in corn, viz: 1840, 1851, 1842 and 1843, and manured each year with a slight dressing of compost, and sometimes cotton seed was added in the hills. The soil is a good yellow sandy loam, such as is considered good cotton land, and has produced about fifteen or eighteen bushels on an average per acre. In the preparation and cultivation of this experiment it was treated in the same manner as A. The rust appeared in various spots over the entire field in which the acre stands, quite early in the season, and was first seen in B No. 2, which is the marled half acre. I attributed it then to some irregularity in spreading the marl, by which some spots were left without any; but on a visit made to me by two experienced James Island cotton planters, who examined this experiment, they informed me that the best lands on their Island exhibited in spots the same appearance, and it was considered a prematurity of the plant, and not the *genuine rust*, as many believed. It was also their opinion that No. 2 was far superior to No. 1, more advanced, and of a better bearing color. The result has been twenty and a half lbs. the half acre, or forty-one lbs. per acre in favor of No. 2, the marled half acre.

Experiment C.—Corn.

Experiment C, Nos. 1, 2 and 3. The field in which this experiment was made, is in every respect like that of B, as it is a part of the same field, separated only by a road. The half acre No. 2 was manured with eight cart loads of compost

in 1843, and planted in corn. Nos. 1 and 3 were not manured with compost, but with cotton seed in the hill, and likewise planted in corn, the yield was a good one, but I do not remember in about what quantity. The stalks of this corn were listed March 5th, 1844, and immediately sixty-six bushels of marl (twelve cart loads) were broad-cast over the half acre No. 3; the whole was bedded with the Davis plough, by running one furrow on each side of the list and the corn planted the same day. From the time this corn attained its fourth leaf, a difference in favor of the marled half acre was visible to the row; and I have it noted on the 10th May, when the crops generally were suffering for rain, the No. 3 was one-third higher than No. 1 and 2 and of a healthy green color. No. 1 was quite yellow and much twisted, and No. 2 a shade better than No. 1. In this state they continued until the rain of the 21st May, when a gradual improvement was visible in No. 1. No. 2 grew off rapidly, but a considerable difference in favor of No. 3 could at all times be perceived.

When the silk from the ears of Nos. 1 and 2 was green and pink, that of No. 3 was brown, indicating maturity of the grain. The blades of No. 3 could have been stripped several days earlier than Nos. 1 and 2, but I preferred taking them all in from the different numbers at the same time, because a difference in the product of corn, it has been supposed, was caused by stripping the blades. In harvesting, I found the ears of No. 3 better filled on an average than Nos. 1 and 2.

Experiment D.—Potatoes (1 to 6).

The field in which this experiment was made, has been at rest for three years, and when taken up for cultivation in the spring of this year (1844), was covered with broom grass. It is a good and grateful soil, of a yellow sandy loam, but very poor from excessive cultivation. After ditching it thoroughly, the cow pen was passed over a portion of it, and the compost and marl broad-cast over also; after which, on the 13th of March, it was all listed, and a furrow run on each side of the list with the barshear plough, covering up the same. It was bedded with the hoe on the 1st April, and planted with cut potatoes on the 3d of the same month. In consequence of the drouth they came up irregularly, and grew slowly; but in no other experiment was the effect of the marl so marked. The superiority of Nos. 2, 4 and 6 on the third of June was so decided, that it was the opinion of several gentlemen. who saw the field on that day, that two acres could be supplied with vines sufficient for slip planting from the three quarters of an acre, Nos. 2, 4 and 6. On the other hand, but few vines could be found in the unmarled, Nos. 1, 3 and 5, that had crossed the alleys. The marled alleys were covered with vines. On the 15th July, no difference could be seen in Nos. 1 and 2. I tested the yield of the different quarter acres, or numbers, on the 18th of October. I could not dig in the entire quarter of each number, as these roots do not keep well, and the loss would have been considerable. We generally dig them as required for use. I therefore dug three rows from the centre of each quarter acre, or separate number; each row is 105 feet long. The cow penned quarter, No. 1, although producing a larger quantity, the potatoes were not as fine as those of No. 2. I selected several that weighed a trifle over three pounds each, but could not find one in No. 1 that exceeded two and a quarter lbs. It never occurred to me, until too late, that I should have weighed the whole.

Discovery of Digging and Carting the Marl.

In a low part of an old inland rice field, with an auger attached to a long rod, I attempted to bore, in hopes of finding marl, but did not penetrate two feet before I was compelled to desist, on account of the rocky state of the ground; these rocks are very numerous on the surface also, many of them bearing the impression of shells. Upon digging five feet deep, I found the marl, but as it was in swamp land, the water springs very fast, and therefore it was abandoned. On an old causeway, which crosses a creek passing through the plantation, I found two

shark's teeth. These teeth are quite numerous in the marl banks on the river, and I concluded that marl could not be far from the surface. I accordingly dug a hole three feet square, in a narrow branch, which leads from the creek and which is overflowed at high tide, and struck the bed four and a half feet from the surface, and not at all troubled with the water; the rocks also appeared to lie in one stratum, and not scattered throughout the upper soil, as was the case in the old rice field.

With two prime hands, I began, on Monday, 26th February, to remove the earth off the marl in this pit, which I marked out twenty feet square; and the labor was not greater than in ditching in a fair soil; but on reaching the stratum of rock, the pick axe had to be used to loosen it sufficiently to allow its being taken in the shovel, and then it was with much difficulty handled. The following table will show the nature of the soil removed from above the marl, &c., &c.:

1. Stratum, marsh mud and roots....................................1 foot
2. Stratum white sand and a few pebbles...........................3 inches.
3. Stratum rocks, closely imbedded in stiff blue clay; these are of irregular shape, filled with holes and the prints of shells. In size they are seldom larger than a whole brick, but generally about the size of a man's fist......1 foot 3 inches.
4. Stratum dark sand, lumps of blue clay and pebbles.................1 foot.
5. Stratum blue and gray sand, with a large quantity of finely divided shelly matter, and numerous muscles, clams and other shell casts in marl, with fish bones and teeth..4 feet 6 inches.
6. Stratum rich marl, of a dingy yellow color, which, by analysis of Dr. Lebby, U. S. A., (Fort Johnson), was found to contain 71 per cent. of carbonate lime..2 feet.
7. At this depth (2 feet) the marl changes color, and contains but 61 per cent.

Into this I have dug five feet, seven from the top of the marl and about twelve or thirteen from the top of the marsh mud or surface soil; the strength of the marl continues about 61 per cent.

I have been troubled but little with water in working this pit. Water oozes slowly through every part of the marl, but so gently as to be rather beneficial than otherwise, by keeping the marl moist and rendering it more easy for the grubbing hoes to penetrate. It is very firm marl, and requires a good blow to drive the point of the grubber two inches deep, when the handle, acting as a lever, crumbles it easily, or breaks it off in lumps, which are soon reduced by a slight blow with the but end of a hoe or grubber.

At the depth of thirteen feet, a prime hand, with a single toss of the spade, throws up the marl to the top of the causeway, where the carts are loaded; and in order to test the height to which it could be thrown, they were ordered to try and see how much higher than the causeway they could pitch it, when I found each of them could throw it five or six feet higher; but I would prefer erecting a scaffold and making two tosses, if I dig deeper than thirteen feet, unless I found it easier to hoist by horse power. On the causeway, where the carts are loaded. I keep an old man (a half hand) to assist in loading, and while the carts are away he breaks up the lumps with the butt of his hoe and hauls the marl into heaps. In carting the marl, I use two carts, each drawn by a single mule; several cart loads, being measured, were found to contain five and a half bushels per load. From several days carting, I have arrived at the following result as an average distance: 600 yards, 19 loads per day each, the carts to be drawn by a good strong horse or mule, and driven by a prime hand. The loads are not tilted out of the cart, but are divided into three heaps and drawn out with a hoe; these heaps are made at regular distances over the land, which insures an equal distribution of the marl. Three hands will be required to dig for two carts, and as before stated, they must be prime hands. In spreading the marl, the same tasks are given as for broad-casting compost manures.

Estimated Cost of Marling Seven Acres of Land.—With two carts, average distance 600 yards, it took five days to cart 168 loads, which gives each acre 24 loads, 5 1-2 bushels each—924 bushels at 1 3-4 cents per bushel.........$12.38

Say 5 days work of 2 carts and mules, at 30 cents per day each...........	3.00
3 " " 3 hands to dig, at 30 cents " " "	2.70
2 " " 2 " " 30 cents " " "	1.20
5 " " 2 " to drive the carts, at 30 cents each..........	3.00
5 " " 1 half hand loading carts, at 20 cents................	1.00
One-half the cost of removing the soil from the pit and preparing the same, before digging the marl—2 hands, 5 days, at 30 cents each, 3.00; half of which is..	1.50
	12.40

The cost of each acre for 132 bushels, at 1.34 cts., is $1.76 6-7.

CHAPTER IX.

OTHER SOURCES OF LIME IN GEORGIA.

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Other Sources of Lime in Georgia.

We have shown that the counties of Burke, Screven, Jefferson, Emanuel, Washington, Laurens, Wilkison, Pulaski, Twiggs, Houston, Macon, Marion, Muscogee, Stewart, Randolph, Lee, Early, Baker, and other counties in the tertiary formation of Georgia, contain deposits of shell limestone and marls sufficient to supply the entire State for unnumbered ages.

The primitive region of Georgia, lying above the tertiary formation, is not wholly without lime formations; crystalline primitive marble has been found in Hall and Habersham counties. The transition, or older fossiliferous rocks of the northwestern portions of Georgia, beyond the primitive formation, embracing Cass, Murray, Chattooga, Walker, Dade and Floyd counties, and portions of Paulding, Cobb, Cherokee and Gilmer counties, will yield inexhaustible quantities of lime for both agricultural and architectural purposes.

We shall, during the progress of the agricultural survey of Georgia, execute analyses of the limestones from all these various formations; upon the present occasion we will present an analysis which will substantiate the proposition that Northwestern Georgia is capable of yielding inexhaustible quantities of lime, equal in agricultural and architectural value to any lime offered in the Georgia market.

The following is the analysis of a limestone from Cass county, Ga., which exists in inexhaustible quantities, lies immediately upon the Railroad, and which is now successfully burned, converted into lime, and shipped to all parts of Georgia:

ANALYSIS 28.—Limestone from Cass county, Ga., quarry of R. L. Rogers, one mile from Cass station, and immediately on the Georgia State Railroad:

100 parts contain:

Carbonate of Lime.	Lime,	52.64
	Carbonic Acid,	41.36
Carbonate of Magnesia,	Magnesia,	1.70
	Carbonic acid,	1.89
Phosphate of Lime,		0.20
Insoluble silicates and oxide of iron,		1.92

This limestone will yield 1052 (one thousand and fifty-two) pounds of lime to the ton; it will therefore prove a valuable source lime for both architectural and agricultural purposes.

The clay which lies upon this limestone, contains from 15 to 30 per cent. of carbonate of lime, and will prove a valuable addition to lands, and especially to sandy lands.

In the southern portions of Georgia, and especially southwestern Georgia, there are extensive deposits of fossil shells, whice are now under examination, and which will, according to the present results of the investigation, prove valuable sources of lime for those counties in which they occur.

Immediately upon the sea coast, supplies of lime may be obtained from the recent oyster shells, which not only exist in great quantities in the marshes and rivers, but are also found in great numbers upon the surface of the sea islands, deposited there in part by the Indians.

The composition of recent oyster shells will show that they will prove valuable sources of phosphate of lime as well as of carbonate of lime.

100 parts of oyster shells contain:*

*Kane.

Carbonate of lime, ...	98.5
Phosphate of lime, ...	1.0
Animal membrane, ...	0.5
	100.0

From this analysis we see that one ton of oyster shells would yield 20 pounds of phosphate of lime, and 100 bushels 100 pounds of phosphate of lime.

Gas lime (lime which has been used for the purification of illuminating gas) will furnish limited amounts of lime for agricultural purposes to the planters living near the cities and towns of Georgia which have gas works. Although this source of lime must necessarily be limited, still it is important that those planters who are disposed to avail themselves of this supply, should understand its general constitution.

The following analysis by Professor Johnston, of the gas lime of Edinburgh and London gas works, will show that it varies in chemical constitution not only in different gas works, but even in the same gas manufactory. The variations arise from several sources.

1st. Variations in the materials from which the gas is manufactured.

2d. Variations in the temperature to which these materials are subjected, causing corresponding variations in the resulting products.

3d. Variations in the length of time to which the lime is subjected to the action of the gas.

	Edinburgh	London.	Edinburgh	London.
Water and coal tar, . .	12.91	9.59	12.91	9.51
Carbonate of lime, . . .	69.04	58.88	67.39	56.41
Hydrate of lime (caustic), .	2.49	5.92		
Sulphate of lime (gypsum), .	7.33	2.77	16.45	29.32
Sulphite & hypo-sulphite of lime,	2.28	14.89		
Sulphuret of calcium, . .	0.20	0.36		
Sulphur, ...	1.10	0.92		
Prussian blue, . . .	2.70	1.80	2.70	1.80
Alumina and oxide of iron, .		3.40		3.40
Insoluble matter (sand, &c.) .	0.64	1.29	0.64	1.29
	98.69	99.82	100.09	101.81

It will be observed that the sulphite and hypo-sulphite of lime, which exists in the proportion of a little more than two per cent. in the sample of gas lime from Edinburgh, is found, on the other hand, to constitute more than 14 per cent. of the sample from the London gas works.

The sulphite and hypo-sulphite of lime will, if present in too great quantities, produce disastrous effects upon the growing crop. The various contradictory accounts with reference to the value of gas lime, are readily reconciled by the facts established by these analyses of Prof. Johnston, that it is by no means a uniform compound.

It is evident that gas lime should not be applied directly to the land, unless its chemical constitution has been carefully determined. Gas lime, however, may with great advantage, even when it contains too much sulphite and hypo-sulphate of lime to be safe as a direct application of lime, be mixed in moderate quantities with swamp muck and stable and cow-pen manure, for it contains but a small proportion of caustic lime, and in the process of fermentation, the action of the atmosphere will convert the sulphite and hypo-sulphite into harmless compounds, and at the same time the gypsum which it contains will absorb and fix the ammonia and other fertilizing gases.

CHAPTER X.

Methods of Applying Calcareous Manures;

Cost of the application of

CALCAREOUS MANURES IN DIFFERENT COUNTRIES.

CHAPTER X.

Methods of Applying Calcareous Manures—Cost of the Application of Calcareous Manures in Various Countries.

We shall endeavor to discuss these subjects in as brief, and at the same time practical and comprehensive a manner, as is consistent with the attempt to excite intelligent action, because the analyses of the soils of Georgia are not yet completed, because no experiments of any very great extent or value, upon the action of calcareous manures have ever, as far as our information extends, been conducted by the planters of Georgia, and more especially because the whole subject will be fully discussed when the Agricultural Survey is completed. We earnestly wish at this stage of the survey, to excite intelligent and vigorous action, and inaugurate an extensive series of careful experiments upon the agricultural value of the calcareous manures of Georgia. Surely the testimonies which we have brought forward to prove the value of calcareous manures in Europe and America, should be sufficient to excite experiment and investigation To those who desire still stronger testimony, and more extensive discussions of these subjects, we would earnestly recommend the valuable work on calcareous manures of the distinguished American Agriculturist, Mr. Ruffin,* to whom the agriculturists of Europe and America are indebted for the first extensive and philosophical and satisfactory explanation of the action of calcareous manures; and to the lectures of Professor James F. W. Johnston,* of England.

*An Essay on Calcareous Manures, by Edmund Ruffin. Fifth edition. J. W. Randolph, Richmond, Va., 1852.

*Lectures on the Applications of Chemistry and Geology to Agriculture, by Jas. F. W. Johnston, M. A., F. R. SS. L. and E., Chemist to the Agricultural Chemical Association of Scotland, &c.

Methods of Applying Calcareous Manures.

Calcareous manures may be applied in two well defined states of chemical combination; either in the caustic state, induced by burning, or in the natural state of combination, in which they are found in nature.

Lime is never found in an uncombined caustic state in nature; it is always combined with some acid, as carbonic, phosphoric, sulphuric, or silicic acids; thus, in marls, shell limestone, oyster shells, and in the crystalline limestones and marble of the primitive and fossiliferous rocks, it exists chiefly as a carbonate, and to a small extent as a phosphate. In this, its natural condition, it possesses no caustic properties; may be taken into the mouth with impunity, and exerts no injurious effects when brought directly in contact with animal and vegetable manures.

The application of heat to these various forms of carbonate of lime, overcomes the union of the lime and the carbonic acid gas; the carbonic acid gas escapes, and quick lime remains. If water be thrown upon quick lime, or if it be simply exposed to the moist atmosphere, it will absorb water, gradually disintegrate, and fall into a powder much finer than could ever be obtained by mechanical means. If this powder of slaked lime be exposed to the atmosphere, it will gradually absorb carbonic acid gas, and be converted back to its original condition before the application of heat.

It is evident, therefore, that the effects of burned lime differ from those of the carbonate of lime, in whatever form it occur, of marbles marl, limestone or oyster shell, only whilst it is in the caustic state; and farther, that when caustic lime is applied to the soil, it is rapidly converted back to its original condition as a carbonate, and its effects then are in no manner different from those of finely divided marls and limestones. Why then should the agriculturist ever burn the carbonates of lime?

1st. Because lime in its caustic state acts more energetically in decomposing the insoluble organic and inorganic elements in the soil. If the chemist wishes to liberate

potash and soda from the earth, he heats it red hot, in a crucible, with lime; after which operation he can extract by the means of water alone, all the potash and soda from the soil. Carbonate of lime will in the soil produce similar chemical changes, but they will be much slower than those produced by caustic lime. The fact which we have before stated and explained, that caustic lime added to manures containing ammonia will cause the rapid liberation of the ammonia, will serve to show the energetic effects of caustic lime upon the organic matters.

2d. Because by heat the mechanical condition of the hard limestones and marls is more thoroughly changed than by any other means which can be employed. The state of fine division induced by the action of heat, renders the lime more active and more soluble. The mechanical division effected by heat, notwithstanding that the caustic lime is soon converted back to the carbonate, is in itself valuable.

3d. Because caustic lime weighs much less (from 10 to 50 per cent., according to the proportion of extraneous matters, as insoluble silicates and water contained in the marls and limestones), than an equivalent of the marls and limestones; if, therefore, it is necessary to transport the calcarous manures to any distance, an important item of expense is saved by first driving off the carbonic acid gas. Whether, however, the diminution of the cost of transportation will pay for the trouble and expense of burning in any given case, will depend entirely upon the cost of fuel and labor. We believe that upon the vast majority of plantations in Georgia, where deposits of lime occur, fuel can be obtained in sufficient abundance, and labor at such a rate as to make the burning of limestones more profitable than their shipment in the natural condition.

We have thus far spoken of marls and limestones, which contain but small quantities of magnesia.

We have a class of limestones which consist, in large measure, of this substance, carbonate of magnesia, which

resembles lime in many of its properties; it is, however, in the caustic state, far more powerful and far more lasting in its action upon the soil and vegetation. We have, however, in the chapter upon the relations of lime and magnesia to soils, shown that when magnesia is combined with carbonic acid, it exerts no caustic or injurious effects upon crops, and in fact is highly beneficial; for, like lime, it forms an important constituent of the structures of both plants and animals. It is best, therefore, to apply magnesian limestones in the state in which they occur in nature without burning. These remarks do not apply to the marls and shell limestone of the tertiary formation of Georgia, for they contain scarcely any magnesia; in their agricultural employment, we may, therefore, disregard this substance entirely. Ma y of the limestones of the northwestern parts of Georgia, on the other hand, contain large proportions of magnesia.

With reference to the time when lime should be applied to the soil, practical agriculturists have determined the rule that it should be applied as long as possible before the crop is sown, because many of the beneficial effects of calcareous manures, as the disintegration of the inorganic and organic matters, and the formation of ammonia and nitric acid from the atmosphere and the elements of plants, is slow and requires time. If the land is in cultivation, it should be applied early in the autumn. It would not be improper to apply marl and crushed limestones and oyster shells to the land at the same time that we apply manures; it would be highly improper, however, to apply quick lime at the same time or immediately before or after the application of manures containing ammonia, for the quick lime will cause the too rapid evolution of this valuable compound.

The amount of lime, marl, and limestone which should be applied to each acre of land, will depend upon many circumstances; the chief of which are, the proportion of lime already existing in the soil, the amount of organic matter existing in the soil, the previous system of cultivation, the climate, and the per centage of lime contained in the calcareous manures.

Land abounding in organic matters, as rich swamps and river bottoms and newly cleared land, and lands which have been highly manured with stable manure and swamp muck, will bear much heavier applications of lime than exhausted lands. Two hundred bushels of lime per acre are often applied to sandy soils, and from three to four hundred on clay soils in the north of England and Scotland, and the dressings of this amount are renewed once in every term of twenty-one years; in Flanders the quantity of lime applied is from forty to fifty bushels to the acre, and the dressing is repeated once in ten or twelve years; in the department L'Ain, in France, eighty bushels to the acre are applied as a preparation for every grain crop. In the department of La Sarthe, the lime is applied at the rate of twelve bushels to the acre, once in three years, in the form of compost. In Maryland one hundred bushels of lime, or from two hundred to four hundred bushels of marl, containing from 20 to 50 per cent. of carbonate of lime, have been applied with success to each acre; and in some parts of Virginia the application has been heavier than this; in South Carolina, on the other hand, these large applications of lime and marl have been found to be injurious rather than beneficial, on account of the almost total neglect of manure and the exhausted state of the soil.

We are convinced that the heavy applications of lime and marls and crushed limestones, so successfully made in England, will not be borne upon the exhausted lands of Georgia, and hence we have recommended the application of one hundred bushels of the crushed shell limestone, and from 100 to 250 bushels per acre of the marls.

COST OF BURNING LIME.

No absolutely accurate estimate can be made of the cost of burning lime in Georgia, for it will depend upon several causes, which will vary in the different sections of the State, such as the price of fuel, the value of labor, and the position of the deposit of lime. The results of similar operations in

other States will, however, form valuable guides in enabling the planters to determine approximateiy the prospective cost:

Estimates of the Expenses and Profits of Burning Lime in Rhode Island, by Charles J. Jackson, M. D.*

Harris rocks, middle hill, soft rock, the manufacturer owning the quarry. Estimated for 350 casks of lime.

Quarrying the limestone $50, carting to kiln $25	$ 75.00
Attendance on kiln $20, and filling out $12	32 00
40 cords of wood at $4.50	180.00
350 lime casks, at 45 cents,	157.00
Carting to Providence, 20 cents	70.00
Rent of lime kiln	20.00
	$534.50
350 casks of lime sell in Providence at $2 net	700.00
	534 00
Leaving profit in burning and value of rock	$165.00
The rock would sell at 12 1-2 cents per cask in ledge, here deduct	43.75
Clear profit in quarrying and burning 350 casks of lime	$121.75

The following is an estimate of expenses and profits in burning the hard rock of the middle hill:

Quarry $35, carting to kiln $25	$ 60.00
Attendance on the kiln $20, and filling out into casks $15	35.00
35 cords of wood, at $4 50	157.50
450 casks, at 45 cents	202.50
Rent of kiln	20.00
Carting to Providence, at 1 shilling per cask	75.00
	$733.34
	550.00
400 casks lump lime, netting in Providence 10s	666.67
40 casks ordinary lime, nett 7 shillings	46.67
10 casks first quality lime, nett 12 shillings	20.00
	$733.34
	550.00
Value of rock in ledge and burning profit	$183.34
Rock worth in ledge 10 cents	45.00
Net profit	$138.34

Estimate of Mr. Wright, who burns lime under the leasees of the Dexter Rock:

*Report on the Geological and Agricultural Survey of the State of Rhode Island, 1839, pp. 59–67.

For the rock in the ledge, for use of kiln, and for the steam engine for pumping water from the quarry	$150.00
Expense of getting out water preparatory to quarrying rock	40 00
Cost of quarrying $50, and hauling rocks out of pit $40	90.00
Drawing to and filling kiln	40.00
Tending kiln $26, filling out $30	56.00
Pointing kiln	5.00
540 casks, at 45 cents	243 00
75 cords of wood, at $5	375.00
Carting to Providence, 20 cents	108 00
	$1107.00
540 casks of lime sell for	1260.00
	1107.00
Profit on quarrying and burning	153.00

Seven turns of 24 hours each—two men employed at $13 each for burning a kiln of lime.

Perpetual Kilns.

The following is an estimate of expenses and profits in burning lime by means of small anthracite coal, in a perpetual kiln, owned by Mr Curtis, in Boston, the limestone being brought from Thomaston, Maine, and costing 50 cents per cask. The kiln burns 26 casks of lime per diem: coal costs from $2.50 to $3 per ton:

26 casks of lime rock, costing 50 cents each	$13.00
2 tons of anthracite coal, ar $3 per ton	6 00
Labor of 3 men, at $1	3.00
Labor of one horse to raise the rock to kiln	50
Interest on cost of kiln, $900, 15 cents per day	15
Cost of 26 casks of lime in bulk	$22.65
26 old lime casks, costing 12 1-2 cents	3.25
Cost of 26 casks of lime for sale	$25.90
The lime sells at $1.12 per cask	29 12
Deduct cost	25.90
Daily profit	$ 3.22

Average profit per cask 12 1-2 cents nearly, or $966 in 300 days. The kiln is kept in action throughout the year.

There must be a considerable variation in the profits at different times, since the price of the coal varies, as also does the price of lime, which sometimes sells for $1.25 per cask. Masons prefer buying freshly burnt lime, since it is more caustic, and there is also a saving, from the fact that no waste takes place by the sifting of lime from the casks, when they have not undergone much disturbance by transportation. Having examined many specimens of lime burned by coal and wood, I feel sure that the lime which is properly burned by means of anthracite is equal in whiteness and in strength to that burned by wood fuel. It is necessary, however, that the workmen should learn by experience how to regulate the draught of the kiln, in order to prevent the fusion of the lime rock into slag.

There is a perpetual lime kiln in Charlestown, owned by Mr. Gould, who burns Thomaston and L'Etang lime rock by means of anthracite small coal. I visited this kiln, obtained a plan of it, and learned the following statistics through the politeness of Mr. Gould:

The kiln cost $900. It is built of Charlestown clay slate, and is lined with

red sandstone. The kiln is 19 feet high, 11 feet across the top, inside 12 feet wide at the boshes (the widest inner part near the middle of the kiln), and two and a half feet wide at the hearth. Limerock costs $2 per ton, delivered at the kiln, equal to 50 cents per cask. Small anthracite coal costs $2.50 to $3 per ton. Three men are employed, whose wages are, for the foreman $35 per month, and the other men receive $1 per day. The kiln burns 30 casks of lime per day, and two and a half tons of coal are burned. The work goes on throughout the year incessantly. The lime sells for from $1.12 to $1.25 per cask. Old casks are used, which do not cost more than 12 1-2 cents each. The casks contain from 278 to 300 lbs. of lime, when of the large size or old casks, and 240 lbs. when the new casks are used.

The lime is well burned, is cold when it comes from the kiln, and is immediately packed into casks and headed up, so that the men attending the kiln are contantly employed. The coal being entirely consumed before it reaches the drawing arches. the lime comes out cool enough to handle.

The pieces are always examined to ascertain whether they are thoroughly burned and free from core, and not slagged. In case the rock is not well burned, it is returned to the kiln. This happens only when very irregular and large masses of the rock are thrown in. It is customary to break the rock into pieces about six by four inches, or somewhere about that size. They ought not to be too small, because there would be danger of fusion; and if too large, they are not well burned.

By the above statistics, it will appear that the cost of burning lime for one year, allowing 300 working days for the year, will be as follows:

Interest on cost of kiln, $900, at 6 per cent	$ 54.00
Two and a half tons of coal per day, per year	2250.00
Lime rock for 30 casks per day, at 5. cents per cask. per annum	4500.00
Labor, 1 foreman, at $35 per month and 2 laborers at $1 per day	7020.00
9,000 old lime casks at 12 1-2 cents	1125.00
Use of horse for hoisting lime rock and carting, expenses 50 cents	150.00
Cost per annum for 9,000 casks of lime	$9,099.00

Therefore each cask costs the manufacturer $1.01.1.

If the lime sells for	$1.12.5
Deduct cost	1.01.1
Profit per cask ... cts..	11.4

Or, on 9,000 casks $1,026 for one year's profit.

Or if the lime sells for	$1.25	
	1.01.1	
Profit per cask, per annum	23.9	—$2,151

Shell Lime.

Shell lime is manufactured in Johnson, by Mr. J. W. O. King, who has erected a kiln for the purpose near Knight's tavern. This kiln I examined, and found it to be 15 feet high, 5 feet in diameter at its mouth, 6 feet in the middle, and 2 feet at the hearth. The arch opening is 2 1-2 feet high, and through this opening the calcined shells are discharged. It contains a charge of 200 to 350 bushels shells, and the burning requires from 8 to 12 hours, according to the degree of completion required. He calcines them but 8 hours for agricultural use, and 12 hours when they are to be used for cement. It requires 350 lbs. of anthracite coal, egg size, to prepare a kiln of lime for agriculture, and 400 to burn the shells into quick lime. The coal costs $8 per ton. The shells used are the quahog and oyster, and they cost him eight cents per bushel, delivered at the kiln. During the past year he has burned and sold 1500 bushels of shell lime. One man only is required to

attend the process of burning. The shell lime sells for 12 1-2 cents per bushel, and is used to some extent in agriculture. Mr. King informed me that he had used this kind of lime on his land with very good results, both by spreading it broad-east, and also by composting it with his manures. He says that he has used it on uplands and on meadows, and on corn, oats, potatoes, and grass, and considers it of great value as a top dressing. It would be easy to make a perpetual kiln after this model; or, perhaps, it would be more economical to build one of large dimensions, as much fuel may be saved in large operations.

Dexter Rock.

At this rock ten kilns of lime are burnt per annum, and there are two lime kilns in use. each of which contains 500 casks of lime. No less than 10,000 casks of lime have annually been sold from these kilns during the last forty years. The establishment is ancient, the rock having been quarried and burnt for more than eighty years. It was leased to a number of individuals, and by them under-let to others. Mr. George Smith furnished me with the following estimate of the cost and profit on burning 500 casks of lime at this place:

Ninety cords of wood, $5	$450.00
Quarrying 500 casks of rock	100.00
Carting	50.00
Packing and burning	75.00
Transportation to Providence	100.00
500 casks, at 45 cents	225.00
Lease	2.25
	$1002.25

Commission, one shilling per cask.

The Smithfield lime kilns are capable of burning 450 casks of lime at a time. They are eleven feet in diameter at the top, bulge in the middle to fourteen feet, and then contract at the bottom to eight feet. The height from hearth to top is twenty-one feet, and the depth back from front to rear is, at the bottom, fourteen feet. Beneath the kiln there is an ash pit, or drop arch, which is kept free from ashes by a scraper. During the burning, a fire-door above closes the opening, when wood is thrown in.

Near the Smith Mansion House, about twenty rods to the eastward, there is a bed of limestone, two rods wide. There is also a lime kiln ten feet in diameter and twenty feet high, capable of burning 500 casks of lime at a charge.

Estimate of expenses and profits in burning 450 casks of lime:

Cost of rock quarried, 77 cents per cask,	$ 346 50
Carting and filling the kiln	30.00
Attendance $24, filling out $13.50	37.50
450 lime casks, at 45 cents	202.50
60 cords of wood, at $5	300.00
Extra expenses, pointing kiln, &c	10.00
Cost of 450 casks of lime at kiln	$ 926.50
Carting to Providence, at 20 cents	90.00
	$1,016.50
Sell in Providence at 14 shillings per cask	1,050 58
Cost	1,080.50
Two per cent. off for guarantee on sales	34 08
	21.00
Net profit in burning 450 casks of lime	$ 13.08

In this estimate we must consider that employment is furnished to the persons concerned, and that they estimate their wages as if employed by others, so we have to consider $13.08 as the clear cash profit beyond labor

Cost of Marling.

The cost of marling will depend upon:

1. The depth of the marl beneath the surface.
2. The presence or absence of water from the marl pits.
3. The distance to which the marl must be transported.
4. The physical state of the marl, whether in hard masses or in powder. The masses, if not very hard, may be broken with an axe or hammer; if, however, they do not fall readily into powder when struck with a hammer, and especially if the marl is composed almost entirely of fossil shells, it should be crushed to a fine powder, in mortars similar to those used in beating rice.
5. The amounts of the carbonate and phosphate of lime, which determine in great measure the quantity of marl which should be applied to each acre. It is evident that rich marl will cost comparatively much less than poor marl for a less quantity will accomplish the same effects.
6. The cost of labor.

Upon hundreds of thousands of acres of good cultivated land in Georgia, marl and shell limestone may be obtained from the hill sides and beds of the streams, without any excavation, as upon the plantation of Capt. Mathew McCullers, in Burke county, and upon the plantation of Dr. J. M. Jones, near the Limestone Spring, and upon the plantation of Mr. Sneed, in Washington counties, and along the banks of various rivers, as the Savannah and Ogeechee, and of various streams, as Briar creek and Buck-head creek.

With reference to the depth at which it would be profitable to excavate for marl, Mr. Ruffin, in his agricultural report on South Carolina, gives, in the following quotation, his opinion of the cost of working this tertiary lime formation of South Carolina, which is identical with that of Georgia:

"Where the marl is naturally exposed on the plantations

on which it is to be applied, and is as easily to be worked as on most lands when so exposed, the labor of marling in South Carolina would cost much less than on any lands of as great extent I have known elsewhere. Add to this abundance of marl, and to its easy access, its far greater richness than the ordinary marls of Virginia, and the general expense of an equally effective dressing, will, in the former country, scarcely equal one-third of the ordinary expense in the latter, so far as to the plantations having within their bounds rich and easily accessible marl. In regard to others less favored in position, the proprietors might profit by transporting to them rich marl more than one hundred miles by navigable river, or ten miles, at least, by land carriage. Unslacked quick lime, whether from shells or marl, or lime stone, might well pay much heavier costs of transportation.

In the much larger portion of the lands of the marl region, though the marl may not be visible, it would probably be reached somewhere, on every plantation, at a depth of from twelve to thirty feet. And even if as deep as thirty feet below the surface, still, if veins of spring water can be excluded, the accumulation kept drawn off without too much labor, then it would be cheaper to draw up marl from below this depth, and even as low as sixty feet, than to cart it three miles. The texture of the great Carolinian bed is so firm, and the thickness of the bed so great, that an excavation may safely be made in it, widening as it descends, so as to be in form like an inverted cone or funnel, of which the narrow pipe would represent the cylindrical well, dug through the overlying earth, expanded to a conical shape below, in the body of the marl. If no considerable veins of water should flow into such an excavation, it might safely be stretched to any desired depth and proportional breadth; and the marl (and water) be easily drawn out by horse power or steam engines, in the manner of raising coal. * * * If the occurrence of water cannot be avoided, before reaching the marl (which may be ascertained by the use of the auger, then perhaps the water may be avoided either by digging pits in alluvial swamps of close soil, which is rarely traversed by veins of springs, or otherwise at the edge of the high land, below or away from where the springs burst out and flow off on either side."

According to the testimony of Francis S. Holmes, Esq.,

which we have presented in full, in a former chapter, the cost of marling each acre was $1.76, and the average cost of each bushel of marl was 1 cent and 3-4 of a cent.

Honorable J. H. Hammond, in the experiments which we have recorded in a former chapter, estimates that the marl which he boated 12 miles up the Savannah river, cost him two cents per bushel, delivered at his bluff.

Professor Phillip Tyson, agricultural chemist of Maryland, states in his recent report that the marls of this State can be delivered on board of vessels for two cents per bushel, including a fair profit, and can be delivered to points fifty and sixty miles distant for four cents; and in his opinion these marls are *worth more* than the Jersey green sand, which is purchased by farmers residing at points distant from the pits, at a cost (including transportation) of 10 to 12 cents per bushel.

We have before shown that the Georgia marls are equal and superior to the Maryland marls.

The following prize essay, which we have extracted entire from the Journal of the Royal Agricultural Society of England, will present an interesting view of the cost of marling in England, as well as of the mode employed with success by many farmers:

An account of the Transposition and Admixture of Soils, as in the application of a Clay-dressing to a light Sand, stating the result of actual experiments. By William Linton.* *Prize Essay.*

Having had several years experience in marling, or the admixture of clay with sand, I venture to give a practical account and a detail of my method; in doing which, I shall notice—

First, The description of the land clayed over.

Secondly, The kind of clay or marl used.

Thirdly, State of the land and season of the year when done.

Fourthly, Quantity laid on, the way of doing it, and the expense per acre.

Fifthly, The result.

1st. The description of land clayed over was a very light barren sand; so barren that it never had been cultivated to profit, but had proved a losing concern to all that had engaged in it, both landlord and tenant. About one-fifth part was entirely out of cultivation, and grown over with ling, gorse, &c. The sub-stratum is a white sand, varying in depth from 1 to 4 feet. The surface was of the same texture, but darker in its color, through the decomposition of vegetable matter upon it. Beneath the bed of sand lay a yellowish kind of clay, about one foot

*Journal of the Royal Agricultural Society of England, vol. 2, p. 67, 1841.

thick; under it a rich marl about 18 feet deep. The land generally being very wet, my first object was to underdrain it thoroughly with tiles; unless this is first done where necessary, marling is a waste of capital. I cut my drains about 24 inches deep and 9 yards apart.

2d. The kind of clay used. This being plentiful in nearly all parts of the farm, but varying in depth from the surface, was more or less difficult to get. The first twelve inches under the sand was an inferior yellowish clay; under it a bed about 18 feet, as already stated, of rich dark colored marly clay, having in it a soft stone, which had the appearance of lime, and also a large quantity of cobble-stones. This clay and soft stone, when dissolved in vinegar and water, effervesced nearly as tartaric acid and carbonate of soda do when mixed together in water; this was my test that it contained a quantity of alkali, which rendered it fit for my purpose, and worthy the name of marl. The top, or yellow clay, dissolved without effervescing. I consider that on the proper testing and selection of the clay or marl, chiefly depends the success of marling operations. All clay will do good, no doubt; but on the quality used must rest the amount of benefit obtained.

3d. The state of the land and the season of the year when done. I have already stated that the land was first drained; in the next place it was made completely by the plough, harrows, and in some places spade, after which it was ready for the marl being laid on, which was done at all times of the year. For the first two years I made naked summer fallows, and laid the clay on in July and August; but after getting the land into a regular course of crops (viz: the four-course system) I then did the work when in seeds in the same months, which I continued to do as much as possible afterwards, for the following reasons: First, to avoid the great injury done to the land by such heavy carting when in fallow, which was visible in some places the two or three succeeding crops. Secondly, from the loss sustained from having a fallow instead of a crop of turnips; and, thirdly, from the cartage being so much easier when in seeds than when in fallow.

The land which was out of cultivation, was pared and burnt with a hope of getting a crop of turnips, but in this I was disappointed. It was also drained and levelled before marling.

4th. The quantity laid on, the way in which it was done, and the expense per acre. The quantity laid on depended upon the quality of the land, and varied from 100 to 200 cubic yards per acre; the average was 150 yards. When the land was very light and barren (which was mostly the case in elevated parts), a larger quantity was laid on; but when it was a better soil, a much less quantity answered the same purpose; my object being to lay just as much as would grow wheat after seeds. To do more than this would not only have been an injury to the land for eating turnips upon it with sheep and for the barley crop, but also a waste of money in extra expense. When sufficiently clayed to grow wheat after seeds, a point requiring close attention, I always found it effectually done for any other crop.

The way in which it was done. It was necessary, in the first place, to fix upon the most favorable situation for the pit, keeping three objects in view. 1st. The most convenient place for carting to the plot of land intended to be marled. 2d. The best situation for a pond to answer for a permanent watering place; cutting, if possible, across a fence so as to water two fields, one from each mouth of the pit. 3d. Where the clay could be got with least difficulty. After the place was fixed upon, the work was carried on by five diggers, a driver, four horses or beasts, and two carts (which are of the Scotch kind, with short bodies and broad wheels).

The pit was dug with a gradual descent, so that three horses could draw out about a ton, which was shot out where wanted, the cart returning by the time the other was loaded; thus three horses were always ready for the loaded cart.

The clay was spread by the diggers at broken times, after being exposed to the action of the air; rain after either frosty or droughty weather, would cause it to fall to pieces sufficiently for harrowing and ploughing in. The expense I paid for digging, filling the carts, and spreading, was from 4d. to 5d. per cubic yard (full 1 ton), varying according to the quantity of stones imbedded in the clay as before noticed The total expense upon an acre having 150 yards laid upon it, was as follows:

	£	s.	d.
Digging and spreading 150 yards, at 4 1-2d per yard	2	16	3
Four horses, four days, 2s 6d. each, 10s. per day	2	0	0
Driver, four days, at 2s 6d. per day	0	10	0
Other expenses (wear and tear	0	3	0
Total expenses in marling one acre	5	9	3

In this way I marled 80 acres, but afterwards hit upon another plan in which I found a great saving to my horses, as in the wet season of the year it was heavy work for them to draw the carts out of the pits. I got a windlass made on the same principle as the one used for the draining plough, which I fixed upon a platform 10 yards from the centre of the mouth of the pit; the platform was formed of the sand taken from above the marl, and was elevated two feet above the surface of the ground. The expense per acre when the windlass was used, was—

	£	s.	d.
Digging and spreading 150 yards, at 4 1-2d per yard	2	16	3
*Three horses four days, at 2s. 6d. each, 7s. 6d. per day	1	10	0
Lad to drive horse in windlass, 4 days, at 1s	0	4	0
Driver for carts, 4 days, at 2s. 6d	0	10	0
Wear and tear	0	2	0
Total expense per acre, when windlass was used.	5	2	3
Total expense per acre when common carts are used	5	9	3
Saving	0	7	0

The advantage is not pecuniary alone, but the heavy drag and difficulty in getting out of the pit is also avoided; and one-third less land is taken up by the pit, as it can be dug much deeper, and to any depth, whilst no difficulty arises in getting out with the loads, even with an inferior horse. The same number of diggers are required.

Fifthly, The result. I have already described the land as being light, and of a very inferior kind; this the crops went to prove, which were generally overgrown with the greatest variety of annual weeds, the growth of which apparently no culture could prevent; but in no instance have they ever made their appearance after the land was clayed over. I cannot give an account of the rotation of crops; previous to marling no regular system could be adopted. It was usual to allow the seeds to remain four or five years unploughed for the sake of ridding the land of the weeds, after which a crop of oats was taken, which would not average more than 3 1-2 quarters per acre. Then followed a fallow, which was sown with rye, and sometimes with turnips, but the land being generally undrained, the latter crop often proved a failure. Barley was sown after the turnips also grass or clover seeds.

The produce in four years could not be stated at more per acre than—

* One horse was used for the windlass, and the other two for taking away the loaded carts.

	£	s.	d.
First year—turnip fallow	4	0	0
Second year—barley or rye	4	0	0
Third year—seeds depastured	2	12	0
Fourth year—oats, barley or rye	3	15	0
	—	—	—
	14	7	0

The same land is now cultivated to the best advantage under the four-course system or rotation of crops. All the fallows are sown with turnips, after which follow barley, seeds which are depastured, and then wheat, which finishes the course of crops. I will here give the produce of four years, after marling upon fallow, and four years after marling upon seeds:

First year—fallow	0	0	0
Second year—wheat, 29 bushels, at 7s. per bushel,	10	3	0
Third year—Seeds depastured	4	4	0
Fourth year—wheat, 24 bushels, at 7s per bushel..	8	8	0
	—	—	—
Produce in four years when marled upon fallow..	22	15	0

	£	s.	d.
First year—wheat, 24 bushels per acre, 7s per bus.,	8	8	0
Second year—fallow turnips	4	15	0
Third year—oats, 52 bushels, at 23s. per quarter..	7	9	6
Fourth year—seeds depastured	4	4	0
	—	—	—
Produce when marled upon seeds	24	16	6
	22	15	0
	—	—	—
Balance in favor of marling upon seeds	2	1	6
The produce after marling in four years	24	16	6
The produce before marling in four years	14	7	0
	—	—	—
	10	9	6

The balance of £2 1s. 6d. in favor of marling upon seeds, does not show that there is any advantage in it over that of making a naked fallow for that purpose, as more than that ought to be deducted for the cultivation of the turnip crop, which would not occur in a naked fallow. But when a naked fallow is made for the purpose of marling the land, then two wheat crops occur in four years, which, notwithstanding it here makes the produce run much higher in the four years than it otherwise would do, could not be long practised with any advantage whatever to the farmer.

The balance of £10 9s. 6d. in favor of marling, needs no comment But in stating these results, I must refer to the comparative merits of the two different kinds of clay used, not by any chemical definition, but from actual experience The clay, whether laid upon seeds or fallow, was shot out in loads as already stated, then spread as equally as possible, but on account of the large size of the pieces of clay, the land could neither be ploughed nor harrowed until it had first dried, then become wet or frozen, and then thawed. After this it was harrowed. The best or dark colored clay will fall long before the top or yellow sort, which is not so easily pulverised. The first named is very productive of itself, but the other requires some stimulant to produce a crop.

If laid upon seeds the land was only ploughed once in October, and drilled in the same month with wheat. When upon fallow it was ploughed two or three times, and well mixed up with the sand, and also sown with wheat. In this way

a good crop was realized without any other manure; but wherever fold-yard manure was applied, the crop was very abundant. On parts of the farm, turnips were often destroyed by grubs, before the land was clayed over, but in no instance have they since; neither have they been destroyed by any other insect, except in 1836, when a few black caterpillars were upon them. A moiety of the Swedes are drained off, but the whole of the white turnips are eaten upon the land with sheep. I find no manure to surpass that from the fold-yard. I tried, by way of experiment, rape-dust, bones and fold-yard manure. The turnips sown with bones and fold-yard manure were equally good, but those with rape-dust were decidedly the worst.

The land is never so productive the first two years, or until the clay has got well pulverized and mixed with the sand, as it is afterwards, and will not grow a good crop or a fine sample of barley for five or six years after the clay is laid on. I have, therefore, sown oats instead.

It is thought by some people that the clay will waste away and require to be renewed in the course of fifty years, or perhaps sooner. On this head I have no apprehensions but am confident that if after the lapse of twenty or thirty years, there were not a particle of clay remaining, the land will have acquired sufficient quality and strength in itself to p oduce a crop of any kind of grain

I am led to this conclusion from my own observations, and think it one that may readily be arrived at by others on referring to the statement of the produce, which is considerably within what I might have stated, had I selected the leading or best crops. This increase in the produee (which is double what it was) returns in part to the land under the four course system.

It may not be necessary for me to add more, as enough has already been adduced to increase exertion in making such improvements upon light sands. I have to regret that I did not commence the above improvements with more determination and to a greater extent from the first; but, being inexperienced in the business, and having but little information on the subject, I was desirous of finding out the best way of doing the work, and of trying the result before I went to any extent. If people would improve the land they have, particularly light land, by draining, marling, &c., they would realize a far greater return for the outlay than by purchasing more. It is a great national loss, and much to be regretted, that so much land capable of being made really good, should lie waste, having a good drainage and a plentiful supply of excellent clay beneath, which is gene ally the case when there is a white sandy surface.

Inferior lands, and especialty light sands, ought not to remain untilled; but, for the common benefit ot the owner, the occupier, and the consumer of the produce, they should be brought into cultivation.

Practical Rules for the Application of Limestones, Marls, Oyster Shells and Lime.

1. Limestones which contain a large proportion of magnesia, should be crushed and applied in the natural state to the land. If these limestones be burned, the magnesia will prove too caustic for the exhausted lands of Georgia. The Magnesian limestones are found principally in the northwestern portions of Georgia. The shell limestones and marls of the tertiary formation of Georgia, contain but

small proportions of magnesia, and hence this rule does not apply to them; when burned, they may be considered as almost invariably composed chiefly of lime, with varying proportions of the phosphate of lime and silicates of alumina and lime, with small quantities of oxide of iron and silicates of potassa and soda.

2. The Limestones and Marls which contain the largest quantities of the Phosphates and Silicates, will prove more valuable additions to land than the pure Limestones, because the Silicates contain valuable fertilizing agents, which are absent in the pure Limestone, and because larger quantities can be applied to each acre, and consequently much larger quantities of the Phosphates will be applied in the increased applications of the Marls and Limestones, comparatively rich in the Silicates and Phosphates, and comparatively poor in the Carbonate of Lime. This rules applies more especially to plantations upon which there are natural deposits of Limestone and Marl; for if it be necessary to transport the Marl or Limestone for any distance by water or land, those should be chosen which are richest in the Carbonate and Phosphate of Lime, for at the present rates of railroad carriage in Georgia, the cost of transportation would more than counterbalance the advantage arising from an increased application of the Silicates.

3. Larger applications of calcareous manures may be made to lands rich in organic matters than to poor and exhausted lands. The best effects of Lime will be manifested upon freshly cleared land—rich in organic matters. Marl and Limestone, containing as much as 80 per cent. of Carbonate of Lime, should not be applied to the exhausted lands of Georgia in larger proportions than 150 bushels to the acre. The deposits of the swamps contiguous to Marl beds and strata of Limestone, both in the tertiary formation and in the older fossiliferous formations of Georgia, frequently contain from 6 to 15 per cent. of Carbonate of Lime, intimately mixed with vegetable matters, animacules and clay—such deposits may be applied to the sur-

rounding sandy hills in the proportion of from 400 to 1000 bushels.

4. Land which has been in continuous cultivation, should, if possible, be allowed to rest for one year before the application of Lime, Marls and Limestone, and the application should be made in the fall of the year, when the ground is covered with vegetation; and the land should then be rested for one year.

5. The question as to the best form in which calcareous manures should be applied to the land, must be determined by the character of the land—the length and character of previous cultivation. Freshly cleared lands, abounding with vegetable matters and stiff clay lands, will be more benefited by caustic lime than sandy soils. It should be borne in mind by the planter that Caustic Lime should be applied in not more than from 1-5 to 1-2 the quantities of Marl and Limestone. An excellent mode of applying lime is to mix the unslaked lime, hot from the kiln, with clay and peat or swamp deposit, and allow the mixture to stand for several months before spreading upon the fields. The Lime will decompose the insoluble silicates of the clay, render soluble the organic matters of the peat and swamp deposits, and liberate the inorganic salts. The method of employing peat and the deposit of swamps in conjunction with lime, will be more fully described in the chapter devoted especially to these manures. In the compost form the same amount of Lime acts more immediately and energetically; and it has been found by experimental agriculturists in France and Flanders, that a much smaller proportion of Lime laid on in the compost form will produce equal effects. In the department of L'Ain, in France, the Lime in its caustic state is covered with earth and allowed to remain until it is slaked, when the earth and it are intimately mixed, and after having rested for a fortnight, are again thoroughly incorporated; in this state they remain for another fortnight, when the whole is uniformly distributed over the ground. In Flanders the Lime is

usually mixed with the ashes of bituminous coal or turf, or formed into a compost with other manures, and the quantity of lime thus applied is from forty to fifty bushels to the acre, and the dressing is not repeated oftener than once in ten or twelve years. In the department of La Sarthe, the lime is applied in the form of compost, at the rate of only twelve bushels to the acre, once in three years; and in the opinion of many most practical and successful agriculturists, this method is not only the least expensive, but is the best. If stable or cowpen manure be mixed with alternate layers of Limestone or Marl, or even with mortar of old buildings, kept under cover, and occasionally watered with urine, or even with pure water, for several months, the nitrogen of the manure will be converted by slow oxydation into nitric acid, which will unite with the Lime and form nitrate of lime. If after the formation of the Nitrate of Lime, ordinary wood ashes be added, the Carbonic Acid of the ashes will unite with the Lime and form the Carbonate of Lime, whilst the Nitric Acid will combine with the Soda and Potassa of the ashes and form the Nitrates of Soda and Potassa. These nitrates are most valuable and energetic fertilizing agents. It will then be advisable to compost a portion of the manure upon each plantation with Marl. We shall subsequently give the results of experiments upon the action of these nitrates.

6. Marl, Limestones and Lime should be applied broadcast upon the surface. We have before explained the reasons for this rule.

7. The full effects of manure can never be obtained without a sufficiency of Lime in the soil. The soils of Georgia, even in the Limestone and Marl regions are deficient in Lime, and hence we would recommend the universal application of calcareous manures in the quantities just specified as the best and only basis for the regeneration of the lands of Georgia.

8. Calcareous manures should never be relied upon alone. Manure should be as liberally and as constantly used after their application as before.

9. Marl and Limestone and powdered Oyster Shells may be applied to the land at the same time with manures containing Ammonia, and in fact may with advantage be composted with cow-pen and stable manure, as we have shown under the 5th rule; it would, however, be improper to mix Caustic Lime with manures containing Ammonia, for it would cause the escape of this valuable fertilizing agent. The rules which we have given apply, therefore, to the composting of caustic lime with peat, clay, swamp deposits, and decaying leaves and organic compounds of forests.

CHAPTER XI.

Other Sources of Phosphate of Lime in Georgia;

Joint Clay of the Eocene Formation.

KAOLIN CLAY OF GEORGIA AND SOUTH CAROLINA.

CHAPTER XI.

Other sources of Phosphate of Lime in Georgia—Joint Clay of the Eocene Formation. Kaolin Clay of Georgia and South Carolina.

We have before alluded to the occurrence of a peculiar kind of clay, which in Burke, Washington, Jefferson, and other counties in the Tertiary formation of Georgia rests upon the Shell Limestone of the Eocene formation. This argillaceous deposit is called in some sections joint clay, from its tendency to split up into small fragments; in other sections of the country, and especially in some of the counties of Alabama where it is found, it is called Rotten Limestone on account of its supposed identity with the Shell Limestone formation upon which its rests.

The analyses which we will present will show that the name Rotten Limestone is inappropriate, for it is composed almost entirely of silicates and silicious sand, and does not contain sufficient lime to place it even amongst the class of Marls. Joint clay is the best name, for it not only correctly characterizes the compound as belonging to the class of clays, but is also expressive of a quality which distinguishes it from other clays. The property of cracking and breaking up into small fragments, when it is thrown out upon the surface, appears to be due in great measure, to the large amount of white angular sand, which is not uniformly distributed through the mass, and to the peculiar chemical constitution of the white clay, which renders it less cohesive than the ordinary varieties of clay.

Although this formation overlies the fossiliferous beds of the Eocene, which are composed almost entirely of fossil shells, and remains of extinct vertebrate and invertebrate animals, still it is almost entirely devoid of fossils, and the few remains which are found in it appear to be mere casts.

Under the microscope the particles of sand found in this clay are angular and not water worn, and it would appear that this deposit had been formed in a deep still sea; and yet if this was its origin, why should the marine deposit upon which it rests be composed almost entirely of organic remains, whilst they are absent from this the succeeding strata. We can satisfactorily explain this great difference between the two formations only by supposing that after the formation of the fossiliferous beds of the Eocene, such a change either in the elevation or in the climatic and physical relations of the Eocene sea took place, that but few organized animals were able to exist during the deposition of the joint clay.

If the bed of the Eocene had been elevated out of the waters, and then again depressed, the joint clay was deposited just after the depression, before animals could have repeopled the new territory again restored to the sea.

As far as my examination extends it appears that in many localities this joint clay has been greatly denuded and washed away in the valleys and low grounds, and is thickest upon the hills. As far as I have examined the deposit in Georgia, it appears to vary in thickness from 10 to 60 feet.

As this clay underlies immense tracts of country in South Carolina, Georgia and Alabama, it is of great moment that its agricultural relations should be determined.

ANALYSIS 29. WHITE JOINT CLAY FROM BURKE COUNTY, GEORGIA. PLANTATION OF J. V. JONES, ESQ.

100 PARTS CONTAIN.

Matters Soluble in Water 0.142.	Carbonate of Lime,	trace.
	Phosphate of Lime,	no trace.
	Phosphate of Iron,	no trace.
	Phosphate of Alumina	no trace.
	Sulphate of Lime,	0.008
	Chlorides,	0.050
	Soda and Potassa,	traces.
	Silicic Acid and Silicates,	0.073

Matters Soluble in Hydrochloric Acid, 10.459.....	Carbonate of Lime 0.501	Lime,....0.280 Car. Acid, 0.221	
	Sulphate of Lime, ...	....	trace.
	Phosphates of Lime,... Iron and Alumina 7.704	Lime,.. O of Ir'n Alumna	6.398
		Ph Acid	1.306
	Carbonate of Magnesia,............		trace.
	Silicic Acid,......................		2.296
	Alkalies, Soda and Potassa,.........		0 169

Insoluble Silicates, chiefly Silicate of Alumina, containing also Silicates of Lime, Soda and Potassa,....54.173
White Silicious Sand,.............................28.461
Water as Moisture,.............................. 6.264

From this analysis we see that this white Joint Clay is capable of yielding nearly 1 1-2 per cent. of Phosphoric Acid.

		PHOSPHORIC ACID.
One Ton (2000 pounds) of Joint Clay will yield..		26.12 lbs.
100 bushels,	" " " ".....	130.60 lbs.
200 bushels,	" " " ".....	261.20 lbs.
300 bushels,	" " " ".....	391.80 lbs.
400 bushels,	" " " ".....	522.40 lbs.
500 bushels,	" " " ".....	653.00 bls.
1000 bushels,	" " " ".....	1306.00 lbs.

This analysis reveals another most important and valuable fact to the agriculturist—this white joint clay contains more than two per cent of Soluble Silicic Acid.

		SOLUBLE SILICIC ACID.
One Ton (2000 pounds) of Joint Clay will yield..		45.92 lbs.
100 bushels,	" " " ".....	229.60 lbs.
200 bushels,	" " " ".....	459.20 lbs.
300 bushels,	" " " ".....	688.80 lbs.
400 bushels,	" " " ".....	918.40 lbs.
500 bushels,	" " " ".....	1148.00 lbs.
1000 bushels,	" " " ".....	2296.00 lbs.

The proportion of alkalies in this joint clay will also add to its value.

It is evident from this examination that this deposit of joint clay will prove a most valuable addition to sandy lands. We would recommend its application in quantities of from 500 to 2000 bushels to the acre, according to the character of the land. It should be applied broad cast in the fall of the year, and

allowed to remain upon the surface until the preparation of the land for planting.

The effect of both the clay and the lime will be increased by mixing either the Shell Limestone or Marl, or better still, unslaked lime, together, and allowing them to remain together under cover for several months.

The effect of the lime will be to decompose the insoluble Silicates, and render them soluble, and thus fit for absorption by the growing plant.

This clay will prove an inexhaustible source of fertility, for it exists in inexhaustible quantities, and on plantations in those counties where it abounds, as in Burke, Jefferson and Washington counties, may be reached by an excavation of only a few feet.

The following is the section of the hill from which this specimen was obtained:

Surface Soil,	12 inches.
Yellow Clay and Sand,	2 feet.
Joint Clay,	50 feet.
Shell Limestone,	Undetermined.

Light Green Joint Clay overlying the Green Marl No. 1, which occurs on the plantation of J. V. Jones, Esq. in Burke county, Georgia. The bed of Green Joint Clay was about two feet in thickness.

SECTION.

Sandy Soil,	2 feet.
Yellow Clay and Sand,	3 feet.
Joint Clay, White and Red,	33 feet.
Green and Yellow Joint Clay,	2 feet.
Green Marl,	Undetermined.

This bed of Green Joint Clay was more tenacious than that usually found in Burke county. Small portions of the bed contained much sand, whilst the greater portion was composed chiefly of this clay colored green by the Silicate of Iron. No green grains like those found in the green sands of New Jersey, Alabama and Europe could be detected in it. We have designated the color of this bed as light green, this is the characteristic but not the universal color, for portions presented a milky white and others a mottled yellow, white, reddish brown

and green color, due to the admixture of the green clay, white clay, sand and Oxide of Iron.

ANALYSIS 30.

Matters Soluble in Water 0.217	Phosphate Lime,		trace.
	Carbonare of Lime,		trace.
	Carbonate of Magnesia,		no trace.
	Sulphate of Lime,		no trace.
	Sulphuric Acid,		faint trace.
	Chlorides,		0.090
	Silicic Acid, / Alumina and Alkaline Salts,		0.126
Matters Soluble in Hidrochloric Acid, 15 220	Phosphate of Lime, Iron, Alumina and Magnesia, .. 1.343	Lime, Iron, Alumina and Magnesia,	0 516
		Phosphoric Acid,	0.827
	Carbonate of Lime,		1.700
	Carbonate of Magnesia,		0.600
	Sulphate of Lime,		0.060
	Silicic Acid, / Peroxide of Iron, / Protoxide of Iron, / Alumina,		10.517
Insoluble Silicates containing small quantities of Soda and Potassa, and also Lime, / Silicious Sand,			71.672
Water as Moisture,			11.891

This clay will yield more than one per cent of the Phosphate and near one per cent of Phosphoric Acid.

	PHOSPHORIC ACID
One Ton of Green Joint Clay will yield	16.54 lbs.
100 bushels " " " " "	82.70 lbs.
200 bushels " " " " "	165.40 lbs.
300 bushels " " " " "	247.10 lbs.
400 bushels " " " " "	330.80 lbs.
500 bushels " " " " "	413.50 lbs.
1000 bushels " " " " "	827.00 lbs.

The amount of soluble Silica in this bed of Joint Clay was less than in the White Joint Clay, and the cause of this difference seemed to be that in the Green Clay, the Silicic Acid had united with Iron, whilst in the white clay the Oxide of Iron and the Silicic Acid were ununited. The bed of green clay although occurring in the same ridge of elevated land, was nevertheless older and had been subjected to a greater number of changes, for it rested immediately upon the Shell Limestone formation, whilst the sample of white joint clay was taken from the bed 25 feet from the surface of the earth,

and 25 feet above the bed of Shell Limestone. We would recommend the application of this green joint clay to sandy lands in the same or greater quantities, and in a similar manner with the white joint clay.

CONCLUSIONS.

(1) The joint clay of the Eocene formation of Georgia contains inexhaustible supplies of the Phosphates.

(2) The joint clay of the Eocene formation of Georgia contains all the inorganic elements necessary for plants and animals.

As far as my investigations have extended, the great fertility of the soil of Burke and Washington upon the hills and elevated land is due to the admixture with the soil of this joint clay and not to the mixture of the Shell Limestone which lies beneath. The low lands and river bottoms of those counties containing the Shell Limestone formation have without doubt, received elements of fertility from the washing of both the joint clay and the Shell Limestones and Marls, for the waters of the streams flowing through these formations are impregnated with the salts of lime, and the deposits from these waters have been correspondingly impregnated with the salts of lime.

3. If properly incorporated with sandy lands, the joint clay of the Eocene formation of Georgia will greatly increase their fertility, and render land which is now almost worthless, highly productive. There are thousands of acres of barren sandy lands which lie in many cases upon this disposit; the discovery therefore of the agricultural value of the joint clay is of importance to the State of Georgia.

It would be highly important and interesting to consider in this connection the agricultural and commercial relations of the other deposits of clay in Georgia; we are compelled however to defer the extended examination of the clays of Georgia to a subsequent report, and will content ourselves with a brief notice of the kaolin clay of the Eocene formation.

Extensive beds of the finest kaolin clay are found both in Georgia and South Carolina in the Tertiary formation, near its junction with the primary formation.

In 1857, a Company, with $80,000 capital, was formed in Augusta, Georgia, for the working of a valuable bed of kaolin in Edgefield District, S. C., six miles from Augusta. At this locality the kaolin bed is 10 feet thick and covers an area of 26 acres. This deposit alone would be sufficient to supply the State of Georgia and South Carolina with the finest porcelain and household utensils for unnumbered ages; and yet this is but one of numerous similar deposits both in Georgia and South Carolina.

The facilities of manufacturing the finest porcelain and china ware in Georgia and South Carolina have been still farther extended by the discoveries of Oscar Montgomery Lieber, * State Geologist of South Carolina. The Felspar needed in the manufacture of porcelain and china ware, has been discovered by Mr. Lieber in great abundance in eastern Pickens and in Anderson.

The city of Augusta has employed the Kaolin Company to manufacture kaolin pipes for their new water works, and for the drainage of the streets. As the value of these pipes have been called in question, we submit a report, which was made by me for the city of Augusta, in my official capacity as Chemist of the Cotton Planters Convention, with the hope that it may prove of interest to other towns in Georgia.

Report on the Kaolin Pipes and Turknett Spring Water.

John Davison, Esq., Member of the City Council and Chairman of the Augusta Water Works.

Dear Sir:—In response to your request to examine the effects of the water of the Turknett Spring upon the kaolin pipes, designed by the city of Augusta to supercede the wooden pipes heretofore used, I have carefully examined the chemical and physical properties of the water of the Turknett Spring, and of the kaolin pipes, and performed experiments upon their mutual actions with the following results:

EXAMINATION OF THE TURKNETT SPRING WATER.

The specific gravity of this water is but very little greater

* Reports on the Geognostic Survey of South Carolina, by Oscar Montgomery Lieber, State Geologist of South Carolina. Report IV, p. 104 and 108.

than that of pure distilled water being 1000.007. The solid residue left after evaporation, equals only four and one-fourth grains (4.25) in the gallon of water. This solid residue is composed of salts of lime, magnesia, Soda, potassa and silica. The water also contains, in common with all spring and well water, carbonic acid gas.

The comparison of the solid matters of the Turknett Spring water, with the results obtained by Chemists from numerous examinations of the drinking water of different countries. will show that the Turknett Spring water is remarkably pure.

The following table presents a general view of the comparative purity of the waters of different springs and rivers:

IN 100,000 PARTS OF DRINKING WATER.

Source of Water.	Solid Residue in 100,000 parts.
Spring de Roye, near Lyons,	26.4
Spring de Fontaine, " "	26.6
Spring in the Jardin des Plantes, near Lyons,	90.8
Spring at the Salmonis apotheke,	130.0
Blackfriar,s deep well, Apothecaries Hall, London,	60.0
Deep Well, Hampstead Water Works,	55.0
St. Martin's Well Charing Cross, London,	100.0
Well in St. Pauls Church yard, London,	95.0
Trafalgar Square Fountain,	80.0
Springs at Hartford, Connecticut,	70.1
" " "	55.1
" " "	30.3
" " "	63.6
" " "	118.2
Seine Water above Paris,	18.2
Water from the Maine,	18.0
Rhone Water, near Lyons	10.6
Water of the Lake of Geneva,	15.2
Elbe, near Dresden,	30.0
Elbe, near Hamburgh,	12.6
Danube, near Vienna,	14.1
Rhone, near Geneva,	18.2
Garonne, near Toulouse,	13.6
Loire, near Orleans,	25.2
Thames, near Greenwich,	39.7
Thomes, near Twickenham,	32.1
Thames, near London Bridge,	36.5
Exe, near Exeter,	15.5
Dee, near Aberdeen,	12.3
Don, near Aberdeen,	12.2
Aar, near Berne,	21.6

If now we compare the solid matters of one hundred thousand parts of the Turknett Spring water, which amounts to

only six and a half (6.50) parts with the solid matters of the drinking waters of the noted rivers and springs recorded in this table, we will find that the drinking water supplied to the city of Augusta compares favorably with each one, and in fact, is far purer than the vast majority of the drinking waters heretofore analyzed by chemists.

The waters of the Turknett Spring, drawn from the pipes now in use, frequently deposits a reddish brown matter. This reddish brown sediment has been formed by the action of the water, atmospheric air, and carbonic acid, upon the iron joints connecting the wooden logs together. This action upon iron is by no means peculiar to the water of the Turknett Spring, and does not signify any unusual activity or strength in its waters. All water, even pure distilled water, will in conjunction with atmospheric air and carbonic acid gas, act upon cast iron pipes, and form the oxide and carbonate of iron. The following example will prove to you that this action is not peculiar to the Turknett Spring water. A service pipe at Grenoble, which delivered ninety cubic feet of drinking water per minute when new, in seven years was capable of delivering only one-half the amount, on account of the formation of nodules of the oxide and carbonate of iron. It is probable that the insufficient supply of drinking water to the city of is due to the formation of these iron nodules at the juncture of the wooden pipes. This examination then demonstrates the purity of the Turknett Spring water.

EXAMINATION OF THE KAOLIN PIPES.

Careful chemical examination showed that these pipes consisted of alumina and silicic acid, and that a good quality of kaolin or china clay had been used in their manufacture. This china clay has arisen from the decomposition of felspar, which in its original state is composed of the silicates of alumina and potassa. During the slow decomposition and disintegration of the felspar, the soluble compounds of potassa have been washed away, whilst the insoluble silicate of alumina remains. This insoluble silicate of alumina, resulting from the decomposition of felspar, is the substance employed in

China, Japan, France, Germany, England, and in a few localities in the United States, for the manufacture of the strongest and most durable vessels.

These kaolin pipes, then, are composed of suitable materials.

The next question to be settled is, whether the waters of the Turknett Spring be capable of dissolving these kaolin pipes?

The following experiments were devised to settle this question definitely.

Experiments upon the action of the Turknett Spring Water upon the Kaolin Pipes.

First Series: Portions of the kaolin pipes were pounded to an almost impalpable powder, and subjected to the action of the Turknett Spring water for various periods, from one day to several days, and then this water carefully tested for the constituents of the pipes, and also evaporated, and the solid residue in a given amount determined, and compared with the solid residue of an equal amount of pure Turknett Spring water. In each case the result was the same; the pipes were not acted upon in any appreciable manner. Similar experiments were performed with distilled water, with the same results.

Second Series: The pounded and broken fragments of kaolin pipe were subjected to the action of boiling water, both pure and from the Turknett Spring, for hours, and then the water tested for the constituents of the pipes, and the solid residue determined, and compared with th solid residue of an equal amount of Turknett Spring water. In each experiment the result was the same; the pipes were not acted upon in any appreciable manner by boiling water.

Third Series: A vigorous stream of carbonic acid gas was passed through the Turknett Spring water containing the powdered kaolin pipe for several days, and the water tested for the constituents of the pipes, and the solid residue determined. In each case the result was the same, the carbonic acid gas produced no appreciable effect.

Fourth Series: These experiments were repeated with large fragments of kaolin pipes.

In each experiment the result was the same—no perceptible alteration, either in the physical or chemical constitution of the kaolin pipes.

These experiments then established:—

1. The purity of the Turknett Spring water.
2. The insoluble nature of the kaolin pipes.

The inability of the Turknett Spring water to act upon the kaolin pipes.

If the publication of this report will tend to remove an erroneous impression from the mind of any one, or tend to render justice to the Company supplying these pipes to the city of Augusta, you are at liberty to use it as you think best.

Very Respectfully Yours,

JOSEPH JONES.

CHAPTER XII.

RELATIONS OF LIME

TO

ANIMAL AND VEGETABLE MANURES.

CHAPTER XII.

Relatations of Lime to Animal and Vegetable Manures—adulterations of Commercial Manures in Europe—Importance and necessity of applying the native Manures—Determination of the best form in which Manure should be applied to the soil—Discussion of the Mineral Theory.

In the preceeding pages, whilst we have strongly advocated the use of the native calcareous manures of Georgia, we have at the same time endeavored to caution the planters against the use of lime alone without manure.

The very effects upon which the great value of lime depends, and its ability to decompose both organic and inorganic compounds, and render them suitable for the absorption and assimilation by the growing crops, should of themselves be sufficient evidences that lime used alone in a system of constant cropping, will finally impoverish the soil. In England this fact has been so well established and known that it has long since passed into an old proverb,

> "The use of lime with manure
> Will always make the farmer poor."

The question immediately arises, what are the best and most reliable sources of manures accessible to the planters of Georgia?

The chief sources of manure accessible to the planters may be classed under the following heads:

1. COMMERCIAL MANURES.

a. Commercial manures imported directly from their

native sources, Phosphatic Guano, Ammonia Phosphatic Guano, Ammonia Guano, Fish Manure, New Jersey Green Sand, Native Phosphate of Lime, Gypsum, Salt, Nitrate of Soda and Bones.

b. Manipulated and manufactured compounds, Manipulated Guanos, Manipulated Fish, Hair, Brick-bats and Red Clay, Super-Phosphates manufactured from bones, Phosphatic Guanos, and Native Phosphate of Lime, &c.

2. NATIVE MANURES OF GEORGIA.

a. *Calcareous Manures.*—Marls, Shell Limestone, Oyster Shells, Limestones of the older formations and Bones. This class of Georgia manures are capable of furnishing also inexhaustible supplies of Phosphate of Lime.

b. Clays containing alkalies and Phosphate of Lime, as the Joint Clay of the Eocene formation.

c. Swamp Deposits, River Deposits, Swamp water, River water, Spring water and Sea water.

d. Vegetable mould, leaves, trash, &c., from uncultivated land and forests, Black Rush.

e. Portions of the crop not consumed upon the plantation as cotton seed.

f. Stable manure, cow-pen manure, human fæces, the excrements of birds and animals in general, ashes.

In the fifth chapter of this report, p. 57, 91, we have given numerous analyses of commercial fertilizers. If we compare the results of these analyses with the chemical constituents of Soils, and plants, and animals recorded in chapters sixth and eighth of this report, we will see that many of the Commercial fertilizers are of great value and contain the elements of plants in a highly concentrated form; we will observe great differences in their chemical constitution—some as the Super-Phosphates contain only two or three of the many elements necessary for the fertility of the soil; others, as Peruvian Guano, contain almost all the substances needed by vegetation; we will also observe great differences in the states of chemical combination and

the physical conditions of the various ingredients; thus in Rhodes' Super-Phosphate we found more than sixteen per cent of soluble phosphate of lime, whilst in many of the phosphatic Guanos the phosphates are in the condition of insoluble Basic Phosphate of Lime, and Bone Earth; thus also in different cargoes of Peruvian Guano the compounds vary greatly, some are in a state highly favorable to the generation of those compounds necessary for the development of crops, whilst others are in a comparatively inert state of combination.

We have farther shown, that independently of the partial and incomplete condition of many of these fertilizers, and independently of their natural variations dependent entirely upon natural causes over which the importers have no control, they have been in many instances both in Europe and America, largely adulterated.

Notwithstanding the testimonies which we have already adduced to show the extensive adulterations of Manures, we cannot refrain from bringing forward the testimony of two distinguished English Chemists who have been very recently extensively engaged in the examination of Commercial manures.

Professor J. C. Nesbit, of Kennington, in his lectures on Agricultural Chemistry thus notices the adulterations of Artificial Manures:

"I will now speak of the nature and extent of the adulterations to which guano and similar substances are exposed. We have seen clearly that the value of guano and other artificial manures depends pretty much on their ammonia and phosphate of lime; it cannot depend on a given amount of sand, or loam, or brick dust, or ground tiles, or any article of that kind, which may be mixed with it; and it is one main object of my lecture, to bring palpably before the practical farmers present a glimpse of the fearful extent to which adulteration is now carried, though it must be very inadequate when compeard with the reality. I feel perfectly incapable of showing one hundredth part of the actual extent of this evil. Gentlemen, you are robbed systematically. It is not simply that a little country dealer buys his ten tons of guano, mixes some foreign matter with it, and then sells it as genuine; there are men who make hundreds and thousands of tons of materials for adulterating guano, which are sold in the market for the express purpose ot adulteration. It is a general system beginning in the metropolis, and extending over the whole country. Even the country cheaters are themselves cheated in turn. The men who come to London to buy their manures very often get an adulterated substance; the article passes through the hands of half a dozen

parties before it reaches the farmer, and when at last it does reach him, it is in an extraordinary state of adulteration, very little indeed of the original matter being discoverable. Guano ought not to contain more than one and a half to two and a half per cent of sand, beside which there should be at least twenty per cent of phosphate of lime, from sixteen to seventeen per cent of ammonia and a considerable quantity of organic matter. Now you can buy guanos in the market, containing from sixteen per cent of ammonia, which is a good genuine article, down to others containing only a trace. It "grows small by degrees and beautifully less," until you have got a thing which contains little else than our good Essex marl, from the Wanstead Flats, or some other place, with a little guano mixed with it to give it the right smell. Another adulterating substance is ground marl from Bow Common.

In fact the whole system of adulteration is so well devised, that, without analysis, it almost impossible for farmer, or the ordinary country dealer, not to be imposed upon. In some cases the buyer has seen his guano taken from the ship's side and has congratulated himself that he was too cunning to be taken in; but unfortunate man! he had quite overlooked the Essex marl or ground tiles concealed in the barge that it might be well mixed with the guano as it went up the river to the appointed wharf. Some parties have three or four wharves for shipment, in various parts of the river, and the same adulterated material is often sent even to the same buyer as two or three separate guanos at different prices. Of course those purporting to be different are shipped to the buyer from different wharves

The two following analyses will give some idea of the adulterations carried on in the manure market: No 1 came into the London market, per ship from Liverpool It was offered for sale by sample, in some places as Peruvian Guano, at £6 10s. to £7 per ton; in others as Saldanha Bay guano, containing sixty per cent of phosphate of lime, at £4 to £5 to ton. The samples were contained in bags of blue paper, purporting to come ex some ship from Valparaiso. About 150 tons were brought into London, the greater part of which found its way to the farmers of Hampshire, no doubt to their great edification and benefit. No. 2 was offered for sale as Saldanha Bay guano at £3 or £4 per ton.

No. 1 Guano (?)		No 2, Saldanha Bay Guano (?)	
Gypsum, - -	74.05	Sand, - -	48.81
Phosphate of Lime, -	14.05	Phosphate, - -	10 21
Sand, - - -	2.64	Gypsum, - -	5.81
Ammonia, - -	0 51	Chalk, - -	22.73
Moisture and loss, - -	8.75	Moisture, -	12.44
	100.00		100.00

Now I will exhibit here a few of these samples of counterfeit guano, for the way in which they are gotten up for sale is really very ingenious. I want the opinion of some of the best informed gentlemen here as to which of these samples is the best. (Mr. Nesbit then handed to the chairman specimens of two kinds of guano, requesting him to state after examining them which he would pronounce the best. The chairman having selected the one which he conceived to be the best, the Lecturer continued)· Well now, this which our chairman has selected as the best guano, is the one which is adulterated and it contains nearly half its weight in Essex marl. (The Lecturer then exhibited in a bottle the proportion of sand to genuine guano in the two samples, showing that in the guano which the chairman had considered the best, the sand and other worthless insoluble materials constituted more than one half of the whole.) In the guano which our President thought best there is 52.8 per cent of sand, though it was sold as genuine. The mode of mixing this sample is clever and peculiar. The whole of the guano and marl are not mixed together at once, but the large lumps being picked out of the

genuine guano, the small is thoroughly mixed with the marl, and then the unbroken large lumps of guano are carefully added so as not to break them. The whole therefore has very much the appearance of good guano; for the lumps in the mixture are merely the guano unadulterated,

Here is another specimen, in which I found 54 per cent of insoluble matter. This contains only 18 grains in 1000, or 1-8 per cent. Remember gentlemen that the strongest smelling guano is not always the best. You cannot tell whether or not it is genuine either by the smell or the color. In fact the only means by which you can ascertain the truth of the matter is by analysis. I will, however, show you one mode of detection which will serve your purpose so long as the adulterators continue to act upon the present system. They now adulterate with a heavy article. If you take five hundred grains of the best guano and five hundred of an adulterated article, and put each into a tube of the same size, you will find the adulterated article much lower in the tube than the genuine one. Here is an illustration. The presence of the sand is shown by the comparative smallness of the space which it occupiés.

I must now show "*the article*" itself—the material for adulteration—it is known in the trade as "*the article.*" It can be bought for the purpcse of adulteration at from 10s. to 20s. per ton. There may, perhaps, also be ten or twenty per cent off for cash,

I hold in my hand five hundred grains of "*the* article." You see "the article" presents a very sorry appearance by the side of genuine guano. Observe the amount of silica which it contains, and then judge what is the extent of adulteration.

I must if possible, compel the attention of all present to this wholesale system of adulteration. It is not as you see, confined to one or two small houses, but the trade in this article is as regular a branch of business in the metropolis as the trade in guano itself. How does this arise? Whence comes all this adulteration? It is partly owing to the farmers nibbling and haggling to get the last penny of profit out of the dealer's hands. He has thus been compelling those who would perhaps otherwise be honest, to sell an article like that which I have been exhibiting.

This is not buying in the cheapest but in the dearest market. Let me here observe, that it is quite impossible for persons who have once begun to adulterate to do so to a small extent. No man can adulterate merely to the extent of ten per cent it would not pay. In the first place an article has to be purchased and worked up, and made to look something like guano; then there is the mixing of this article with the guano. The whole process is expensive; and every particle of the cost, with a large profit superadded, must be paid by the farmer who buys the adulterated article instead of the genuine one. The probability is, that he does not get in return for his money more than one fourth or third of guano; but all the rest is sand or ground tiles, or loam, the carriage of which is of course another item of cost to the farmer.

I have often remarked that if it were possible for chemists to concentrate manures, so that they would be worth even £50 a ton, it would be an immense advantage to those who have to use them.

If guano for example, could be concentrated four fold, it would for that very reason be the most valuable manure the farmer could use; since, being of small bulk, the cost of carriage would be decreased four fold. To return however from this digression.

I was observing that it would not answer a dealers purpose to adulterate to the extent of ten—I might even say—twenty per cent; nor indeed do dealers confine themselves to such a small proportion. These adulterated manures are sold some at £5, some at £6 and some £8 per ton. The best of them are adulterated more

than 40 per cent, and in many cases the adulteration is as much as 60 or 80 per cent.

It remains for you gentlemen to put a stop to this imposition. I can scarcely offer any other practical means of detection than that which I have just mentioned —that of observing and comparing the different degrees of specific gravity or bulk of the samples. Let me tell you too that even if you do buy of a first rate party, it is still possible you may be deceived. I will quote Dr. Anderson's opinion on that point; and the extract will show that even parties who wish to sell a genuine article are often misled. In an article on guano, in the "Royal Highland Society's Journal" he says: "all the risk and uncertainty to which the farming public is now subjected might be avoided, if buyers would give up seeking for cheap guanos, buy from dealers of character, and insist on their purchase being guaranteed as the same composition as a sample analyzed by some chemist of known accuracy.

It must however, be distinctly understood that all these precautions are necessary for there are such things as selling guano by fictitious analysis; and I have known instances in which dealers of the utmost respectability and altogether above the suspicion of fraud, being in the habit of selling guano without analysis, have bought in the same way, and have become the unconscious instruments of introducing a grossly adulterated article into commerce."

I say then that even respectable parties may be deceived. There are gentleman in the trade who would I believe scorn either to adulterate or to sell an inferior article as the best; but even these gentlemen may be deceived. Stiil one way in which you may endeavor to secure yourselves is by dealing with first rate men—who have a character to lose and who are not therefore likely to adulterate. At the same time, I must confess I see no effectual security except that which consists in your having samples of the bulk you buy analyzed. Look at Scotland. The Scotch farmers have their samples analyzed and the bulk tested; and they have often recovered damages when the two have not corresponded.

Other manures are also adulterated in similar ways. Nitrate of Soda is mixed with a well prepared sulphate of magnesia, or epsom salts, whose crystals are almost undistinguishable by the eye from the crystals of nitrate of soda—sulphate and other salts of ammonia are also much adulterated. There are in fact, a thousand ways of adulterating manures, and you can scarcely ever be sure, under present circumstances, that you are applying to your land a really genuine article. Take super-phosphate of lime. If you do not buy from a respectabls house, you will be sure to have large mixtures t fifty per cent and in some cases seventy-five of worthless material mixed with the genuine substance.

I have letters from various gentlemen, including Professor Calvert of Manchester, and Professor Anderson of Edinburgh, all corroborating the fact of the immense adulteration of artificial manures.

They have all analyzed samples of guano which nave been highly adulterated. Prof. Calvert informs me that he has analyzed some which contained from seventy to eighty per cent of sand.

I must now mention a recent attempt to obtain money from the public, of so ridiculous and presumptuous a character that I hardly know how to allude to it. I mean the fertilizing of seeds. Many years ago it was proposed to steep seeds of various kinds in solutions of manure, or to roll them in some manuring powder, which, adhering to the seed, would render good service in quickening its germination and promoting its early growth. There is nothing unreasonable in this, and in many instances some good has been done by the process. But within a few years, both here and in France, parties have come forward to do away altogether with ordinary manuring, and to give such a coating to the seeds as will carry them well through till harvest. Yes your boasted farm yard dung, your Peruvian

guano, your super-phosphate of lime. are now, by the "discoveries of science' rendered wholly useless! Only put three or four pounds of a powder over the seeds for an acre of land, and you may then with your hands in your pocket joyfully await the hundred fold increase of a teeming harvest! Now in the first place I, as a chemist should condemn the thing at once; and as to you practical men, I should think you must be of the same opinion as the Scotch farmer, who when the laird remarked to him, "Donald the time will come soon when we shall be able to carry the manure in our snuff box," replied yes, when that time comes we shall be able to carry the crop in our waist coat pocket." We have been told that most astonishing results have arisen in France from the use of fertilizing powder on seeds. Being a corresponding member of the French Central Agricultural Society, I took the liberty of writing to M. Pagen, who is one of the Professors of Chemistry in the Ecole des Arts et Metiers, and who was lately in this country for the purpose of inquiring into the state of our artificial manure manufacturers. In reply to the letter which I wrote to him that gentleman says: "The exclusive use of a small quantity of powdered manure to envelope seed, would evidently be both dangerous and prejudicial to the true interests of both farmer and landlord. I am authorised to add that this is also the opinion of my friend Boussingault and of my other colleagues, the members of the Central and National Society of Agriculture. Besides the experiments already made in France and duly controled by Messrs. Moll and others, were not at all successful. The numerous publications favorable to this ridiculous system of cultivation without manure, do not deserve any confidence, for they were paid for by the speculators and inserted by our gazettes as common advertisements or publications of chemical results."

So much for the opinion of the French savans; and I apprehend that if it has not answered in France it will not in England. If indeed we could concentrate the virtue of twenty loads of farm yard dung into one pound, it would be an excellent thing for the cause of agriculture.

But now for the analysis of this precious manure, for which I paid at the rate of twenty shillings for four pounds and a half, or at the moderate and unassuming price of £497,155 6 1-2d. per ton.

The very first thing which presented itself was fifty-five to fifty-nine per cent of carbonate of lime—or common chalk! I will give you the full analysis. Composition of a sample of fertiling powder, at the price of twenty shilling for four and a half pounds weight:

Silica,	6.45
Moisture,	4 91
Organic Matter,	25.79
Nitrogen,	1.47
Carbonate of Lime,	55 59
Potash and Soda,	0.92
Sulphate of Lime,	1.71
Iron not determined,	——
Phosphate of Lime,	0.96
	97 80

You must all consider the article too dear at the price.

I have thus brought before you the nature of and extent of adulteration. My main object has been that the reality should go forth to the agricultural world. I believe—in fact I know—that there are parties in London who are making several thousands a year by adulterating manures. The names of some of these men are scarcely known in the market, but what they manufacture finds its way to the land. It is not such gentlemen as yourselves who are chiefly exposed to this evil; you can protect yourselves; but there are many of the poorer classes of farmers

who are continually imposed upon without knowing it, because they endeavor to buy two tons of guano for £13, instead of being contented with one for that amount. I have placed the matter before you, because I think it ought to go forth to the agricultural world that farmers are being imposed upon in this matter; that they are constantly buying sand for guano, and oyster shells for bones; that they are not merely cheated here and there, but that parties make it their business to manufacture *The Article* for no other purpose than that of mixing it with manure. When all this is known the remedy is in your own hands. In the first place, you should deal only with men who have a character to lose and who will not endanger their position by any thing like deception.

In the second place, you should not neglect to avail yourselves of the security afforded by analysis. The facilities for obtaining an analysis are much greater than they were. If agriculturists generally were vigorously to pursue this plan, I believe its necessary effect would be to put a stop to adulteration, to drive the dishonest dealers from the market, and leave the manure trade in the hands of honest and honorable men.

"On Agricultural Chemistry and the Nature and Properties of Peruvian Guano," by J. C. Nesbit, F. G. S., F. C. S., etc. Principal of the Agricultural and Chemical College, Kennington, &c., London, 1857, p. 34, 51.

Professor Charles A. Cameron, M. D., of Dublin, in his recent work upon the Chemistry of Agriculture, thus notices the adulterations of Guano and Commercial Manures:

There is, perhaps, no article of which large quantities are sold, more liable to adulteration than Guano. Demand and supply, of course, act on each other. The limited supply, the consequent high price of the article, and the avidity with which purchasers take the bait of cheapness are, no doubt, the combined causes of the extensive practice of sophistication. It may be said that the demand is greater than the natural supply. Men, whose ingenuity and avarice are more extensive than their consciences, step in and supply, or affect to supply, the deficiency; and as the addition which they make to the stock costs little, and is worth less, they are safe in offering it at a price so low as, in most instances, to be irresistible to the confiding farmer.

The substances with which Guano is adulterated are sand, clay, powdered bricks, marl, chalk, limestone, salt, &c., one or more of them being added to Guano, generally to the strong smelling Ichaboe or damaged Peruvian, the proportions, of course, depending upon the conscience of the compounder, and on the presumed gullibility of the purchaser. So skilfully are these compounds prepared, that the most experienced buyers are often imposed upon, detection, in very many cases, being very difficult by any except chemical means. * * * *

No artificial manure should be bought without the buyer previously obtaining an analysis, setting forth its exact composition. Testimonials are seldom to be relied upon. In numberless cases the most worthless manures have been palmed upon the unsuspecting farmer by means of spurious testimonials.

A correct analysis can alone be depended upon; and even this in not a few instances, proves unavailing. The analysis may be correct, but it is practically of no value to the farmer unless he understands it; and not only so, but a true statement of the composition of a bad specimen may, to him, appear that of a good one; and he may purchase the bad under the impression that as an analysis is given at all it is as a guarantee of the genuineness of the article. Relying upon this very natural mode of reasoning on the part of the purchaser, the fraudulent dealer resorts to this audacious expedient in order to avoid being prosecuted for selling otherwise than according to the analysis! I am informed that an an-

alysis made, by myself, of a perfectly worthless sample of guano was used last season, and with considerable success, actually to recommend an article which possessed no value whatever! So long as buyers are unacquainted with even the elementary principles of Chemistry, so long must we expect this system to be pursued.

Let us hope, however, that this is a state of things which will not long continue. If fraud is abroad seeking for prey, science is on its track to discover and disarm it; and even the agricultural portion of the community, though so widely dispersed from the great urban centres of scientific light, cannot long remain in ignorance of that science which must be regarded as the farmers' best friend and safeguard, and the true exponent of his noble art.*

In the fifth chapter of this report we have demonstrated by an impartial and extensive comparison, that we have in Georgia, inexhausiible supplies of one of the most important of all fertilizers, the Phosphate of Lime, a substance which enters largely into the composition of guanos.

In view of the extensive adulteration of Guano and artificial manures—in view of the great variations in the composition of even honestly imported Guanos—in view of the fact that the Phosphate of Lime, the constituent which enters most largely into the composition of Commercial Manures, can be obtained in inexhaustible quantities upon our own soil—in view of the well established fact that the addition of Super Phosphates or Phosphatic Guanos to marled lands, is productive of no special beneficial effects, because the Phosphate of Lime has been already supplied in sufficient abundance to supply all the wants of vegetation—in view of the fact that there is no law in the State of Georgia, compelling the venders of fertilizers to throw open their entire stock to the inspection of competent Chemists, I would decidedly recommend to the Planters of Georgia, the abandonment of all commercial and manufactured manures, whose chemical constitution and true values have not been determined, and employ the resources found upon every plantation in the State.

Before considering the other native sources of manure,

*Chemistry of Agriculture, the Food of Plants, including the Composition, Properties and Adulteration of Manures, by Charles A. Cameron, M. D., Professor to the Dublin Chemical Society, Lecturer on Chemistry and Natural Philosophy in the original school of Medicine, Dublin. 1857, p. 116, p. 135.

we will endeavor to settle, in a definite manner, the question whether the mineral constituents of plants be all that it is necessary to return to the soil, that its fertility may be retained.

Determination of the best form in which Manure should be applied to the soil—Discussion of the Mineral Theory.

Every fertile soil contains all the inorganic elements necessary for the development and perfection of plants and animals; the atmosphere contains immense stores of Carbonic Acid, Ammonia and Nitric Acid and watery vapor: the soil and the atmosphere therefore contain all the substances necessary for the development and perfection of vegetation.

Geology teaches that plants preceeded animals upon our earth, the first plants must, therefore, have derived all their elements from the air and the water. These and similar facts have led certain chemists to assert that if the mineral constituents of plants be furnished, the atmosphere, with its moisture and rains, will furnish all the necessary elements in sufficient quantities for the development and perfection of all plants.

Whilst we admit the truth of the proposition, that plants will attain perfection and yield perfect fruit upon a soil devoid of organic matter, still we maintain that the luxuriant crops, demanded by the present state of civilization, cannot be produced on land wholly devoid of organic matter.

The determination of the best form for the application of manure, and of the value of the organic compounds in manure, is of great importance to the Planter for three reasons.

1st. If the mineral constituents are alone valuable, the difficulties of transportation would be greatly lessened by burning his bulky manures, collecting the ashes and applying them to the soil.

2d. Great numbers of the manipulated compounds and manufactured manures are composed alone of the inor-

ganic (mineral) constituents which enter into the constitution of plants.

3d. If the mineral constituents are alone valuable, then, the burning of the deposits of forests would produce no ill effects whatever.

We will now endeavor to settle this question in a brief but conclusive manner.

(*a*) Whilst it is true that certain plants are capable of living almost entirely upon the atmosphere; whilst it is true that certain plants are capable of flourishing upon barren rocks, it is also true that the plants which live most entirely upon the atmosphere and water, and the plants which form upon barren rocks, lava streams and coral islands are those of the most simple organization.

The flat, simply organized lichens covering the bald granite rocks of Middle Georgia are familiar to every resident of this section of our State. Along the sides of Etna, Ischia, Vesuvius and other volcanoes, lava streams are seen stretching in all directions, which have flowed down like rivers. These lava streams are of different ages, and many of them were formed within the memory of man. An investigation of these lava streams has afforded the agriculturist an opportunity of determining the gradual preparation of soil for vegetables.

Some are still naked, others have only a few plants scattered here and there in hollows and crevices—on others the decaying plants are forming a soil, whilst the oldest streams are covered with the disintegrated rocks and decaying vegetables and crowned with a luxuriant vegetation. The plants which first settle upon naked land and upon barren rocks generally, and form a soil for the more highly developed plants, are the hardy and simply organized lichens and mosses. Upon the soil formed by the disintegrated rocks, and by the decaying lichens and mosses, more highly succulent and fleshy plants appear; these dying in like manner return to the soils the salts absorbed from the rocks, locked up as it were in the surrounding organic mat-

ter, and are in turn succeeded by more highly developed plants; it is evident, therefore, that wherever vegetation is undisturbed the soil progressively improves not merely by the addition of mineral compounds, but also by the addition of organic compounds, capable of undergoing slow decomposition, and during this slow decomposition, of forming compounds necessary for the support of vegetation, and of slowly liberating the mineral matters obtained from the soil.

(*b*) The distinguished agriculturist, Boussingault, has shown that whilst the seeds of leguminous plants sown in pure earth and moistened with nothing but distilled water, obtain an increase of nitrogen which the admosphere alone could have afforded, those of barley and other ceralia remained in that respect stationary, unless manure capable of yielding ammonia and other compounds of nitrogen are afforded.

(*c*) The researches of Baron Liebig have established the fact that ammonia does actually find its way into the vegetable organization; for he has ascertained that the saccharine juice which flows from the different varieties of maple, contains a large proportion of ammonia, and the juice extracted from beet-root and the products of the distillation of various herbs, flowers, fruits, grain and roots, with water contain ammoniacal salts. These ammoniacal salts have been derived both from the atmosphere and from the soil.

The experiments of Professor Cameron, of Dublin, have established the important fact that one of the most common and abundant constituents of the urine of animals, urea, can be absorbed and assimilated directly by plants. The results of these investigations are so important, that we take the liberty of presenting to the Cotton Planters' Association, the entire article. The hygienic bearings of this article are especially worthy of attention, for the time must come when the cities of Georgia will equal, if not rival, those of England, Scotland and Ireland; and I may say, with truth, that we are already suffering from the same

causes of disease which afflict the more crowded cities and countries of Europe.

On Urea as a Direct source of Nitrogen to Vegetation. By Charles A. Cameron, M. D., *Professor to the Dublin Chemical Society, &c, at the Meeting of the British Association for the advancemenu of Science. held at Dublin, Augnst,* 1857.

In the progress of the science of Agriculture we have arrived at a s'age at which we understand the importance of affording to plants an abundant supply of liquid food. At this point the economic and scientific agriculturist and the sanitary reformer meet. The agriculturist wants liquid manure, and those who have the care of the health of the inhabitants of large towns wish to get rid of oceans of that article, and yet to an appreciable degree neither party has been accommodated.

There seem to be some two or three problems which must be solved ere this demand on the one hand, and the supply on the other, can be made; as we say in Chemistry; to neutralize each other. In the great laboratory of nature, the exchange of carbon and oxygen between plants and animals is carried on without labor, difficulty, or expense, and to the essential advantage of both. A similar exchange of the fruits of the earth for the liquid and solid refuse, with which mankind wishes to dispense, is only a question of time, and one which we shall, ere long, see among the recognised facts of advanced civilization.

How to dispose of the sewrage of London, and yet preserve the water of the Thames from pollution is well-known to be one of the great questions of the day. A similar one is now forcing itself upon the attention of the citizens of Glasgow, and what was, until lately, looked upon as a sanitary question has now become one of pounds, shillings, and pence to the shipping interests of that enterprising city. I find by the Scotchman of Saturday last that the passenger trafic of the Clyde is already injuriously affected by the noxious effluvia sent forth by the discharge into that river of the sewage of Glasgow. In Edinburgh the question assumes the alternatives of stopping the great Caledonian distillery or covering in the water of Leith—the Illi-sus of the "modern Athens"

In Portobello the inhabitants are desirous of having their sewage conveyed into the Firth of Firth, but those interested in the preservation of the beauty of the beach stand in the way of doing so. In Dublin we are at a somewhat similar stand; and whilst those several communities are thus anxious, and actually laboring and spending to make a present of their abundant supply of liquid manure there are as many around them willing to pay liberally to get possession of it. There can thus be little doubt that there is a vast amount of capital ready on every hand to be invested in carrying out practically the true idea of bringing the supply, and demand which I have just mentioned into profitable contact

The next want at this juncture is what must be supplied by science. mechanical and chemical. The mechanical means by which our health and wealth can, in this respect, be so materially promoted will, no doubt, claim the attention of the mechanical section of the Association, whilst any contribution towards completing the Chemistry of the subject will meet with due consideration from the section which I have the honor of addressing.

Although the great value of the drainings of our cities and farm-yards is allowed by all, those who understand the present position of Agriculture know that there are some points of considerable practical importance upon which there is a diversity of opinion entertained. In reference to the time and state in which draining should be applied to the soil there are, two opinions and two practices, the great majority being, I am sorry to say, on the wrong side of the question. It is asserted by the greater number of Agriculturists that, in the language of the farm,

the drainings ought to be allowed to ripen, or in the language of science, to ferment and produce ammonia, before they are administered as food to the plants; the supposition being, that the urea, which constitutes the most valuable portion of the fertilizing constituents of the drainings, must be converted into ammonia before its nitrogen can become available for the purpose of vegetation.

It is a curious and suggestive fact that the Chinese, who are so remarkable for their industry and minute economy, apply their liquid manure immediately, and without allowing time for its fermentation and consequent production of ammonia. They thus in a great measure, especially for the whole of that period during which the article is in immediate demand to promote the growth of the plants, dispense with tanks for preserving the drainings, and do not incur the loss occasioned by the formation and escape of volatile ammoniacal compounds, which so generally attend the process of what the farmer calls the *ripening* of his liquid manure. It is very probable that these *prima facie* economical considerations were the main reasons for the Chinese adopting this as a practice, and yet certain experiments which I have made satisfy me that they are right in science as well; and I consider it no small matter to have my *earthly* theory supported by such *celestial* practice. That theory is, that nitrogen is as available as food for plants, whilst a constituent of urea as it is in its ammoniacal combination; or, in other words, that urea, without being converted into ammonia, may be taken up into the organism o the plant, and then supply the necessary quantity of nitrogen. The experiments which have led me to this conclusion I shall now proceed to describe.

EXPERIMENTS.

Four earthenware basins, each two feet in depth, and 2 1-2 feet across, were filled with fragments of felspar, of different degress of fineness; the coarsest fragments being placed lowest. In each of these basins 60 grains of barley were sown on the fifth of May. The basins were then numbered 1, 2, 3, and 4, in each was placed a portion of an artificial manure containing the following substances, viz:

The double silicate of potash and soda, precipitated carbonate of lime, freshly precipitated phosphate of lime, phosphate of magnesia, and chloride of sodium. The bases and acids of this compound were in such proportion as nearly to correspond with the composition of the ash of the barley plant.

In addition to the above-mentioned substances (which it will be observed, contain no nitrogen,) a solution of urea was applied twice in each week to basins Nos. 1 and 2, and solution of sulphate of ammonia to No. 3. No. 4 was intended as a check upon the experiments with the urea, and to it therefore no nitrogenous substance was applied. All the basins covered with glass shades; the air supplied to the interior of each being freed from ammonia by treatment with dilute sulphuric acid. The urea used in my experiments was prepared by the following process:

28 parts of dry ferrocyanide of potassium and 14 parts of peroxide of manganese, thoroughly mixed, were heated to dull redness. The resultant mass, after cooling, was treated with cold water, and the solution thus obtained mixed with 20.5 parts of crystallized sulphate of ammonia; sulphate of potash and cyanate of ammonia were formed, and the latter, on the application of a gentle heat, was converted into urea. I did not seperate the sulphate of potash, as its presence did not interfere with the results of the experiments.

The felspar in basins Nos. 1 and 2 was occasionally washed with distilled water, and the washings tested for ammonia. I did not however, in any instance, detect the presence of this substance, which proves that urea was not converted into ammonia.

The barley experimented on was the variety known as Chevalier barley. The growing plants were supplied with carbonic acid gas and carbonated distilled

water. The plants were thinned at an early stage of their growth, so that there remained but 15 plants to each square foot of surface.

The results of the experiments were as follows:

No. 1. Period of complete germination, within 5 days.
Period of ripening within 107 days.
Mean height of plants, including the ears, 29 inches.
Average return from the seed, 9 stalks.
Average produce in seed, 28 grains from each stalk.
Size of grain, 14,786 to the pound.
Amount af nitrogen in 100 parts of the dried grain, 2,470.

No. 2. Period of perfect germination, within 6 days.
Period of ripening, within 112 days.
Mean height of the plant including ears, 26 inches.
Average return from the seed, 10 stalks.
Average produce in seed, 27 grains from each stalk.
Size of grain. 14,672 to the pound.
Nitrogen in 10 parts of the dried grain, 2,385.

No. 3. Period of complete germination, within 8 days.
Period of ripening, within 105 days.
Mean hight of the plants, including the ears, 22 inches.
Average return from the seed, 12 stalks.
Average produce in seed, 25 grains from each stalk.
Size of grain, 15,607 to the pound.
Amount of nitrogen in 100 parts of the dried grain, 2,388.

No. 4. Perfect germination took place within 8 days, and stalks, on the average 8 inches in length were produced; but in no instance were seeds developed.

The following conclusions are, I consider, deducible from the results of my experiments:

1. That the perfect development of barley can take place, under certain conditions, in soil and air, free of ammonia and its compounds.

2. That urea in solution, is capable of being taken, unchanged, into the organism of plants.

2. That urea need not be converted into ammonia before its nitrogen becomes available to promote the process of vegetation.

4. That the fertilizing effects of urea are not inferior to those of ammonical salts.

5. That there exists no necessity for allowing drainings or other fertilizing substances containing urea to ferment; but that, on the contrary, greater benefits must be derived from their application in a fresh or unfermented state.—*Journvl of Agriculture, Edinburg, October*, 1867. *Also Chemistry of Agriculture, The Food of plants; including the composition, and adulteration of Manures. By Charles A. Cameron, M. D., Professor to the Dublin Chemical Soeiety, &c., &c. Dublin*, 1857, *pp.* 137–144.

The readiness with which the organic acids formed during the decomposition of vegetable and animal manures unite with ammonia, and the tenacity with which their union is maintained, and the greater solubility of the compounds thus formed, still farther support the view that certain of the organic products of the decay of vegetable and animals are absorbed directly by plants.

d. Whilst a large portion of the carbonic acid gas consumed by plants is furnished by the atmosphere, and whilst it is true that the same amount of carbonic acid gas would be poured into the atmosphere from the vegetable and animal kingdoms, whether the dead and excrementitious vegetable and animal matters be burned with fire, or be slowly converted into carbonic acid gas, ammonia, nitric acid, and salts by the slower play of chemical affinities during decay; it is also true that vegetables derive much of their carbonic acid gas and compounds of ammonia from the humus and decaying animal manures surrounding their roots; and the very slowness of this decay is adapted to their gradual growth and development.—Each particle of humus and manure during its slow decay is surrounded by an atmosphere of carbonic acid gas, which is partly dissolved by the water in the soil, and thus enters through the roots into the plant, and partly also ascends into the atmosphere and is absorbed by the leaves. It follows as a necessary consequence that the greater the proportion of animal and vegetable matters undergoing decay, the greater will be the amount of gaseous plant food generated.

(*e.*) The property of charcoal, originally pointed out by Saussure, of absorbing and condensing within its pores carbonic acid, ammonia, and various other gaseous matters, has been demonstrated by the experiments of Professor Charles Daubeny, to be also possessed by vegetable mould. Professor Daubeny found that both carbonic acid and ammoniacal gases were condensed within the pores of vegetable mould, as they would be within those of a lump of charcoal. The celebrated Baron Liebig has confirmed this statement.

It follows as a necessary consequence that the greater the amount of vegetable mould in the soil, the more rapid and abundant will be the absorption of carbonic acid and ammonical gases from the air. This statement is not at all affected by the fact established first by Faraday, that

all earthy and metallic powders absorb ammonia and carbonic acid gas, when present either in the air or in the bodies with which they are brought in contact, nor by the fact established by Liebig that clay and the oxides of iron and other elements of the soil possess the power of absorbing these gases from the atmosphere; for vegetable mould far exceeds the other constituents of soils in the power of absorbing not only ammonia and carbonic acid gas, but also watery vapor from the atmosphere.

(*f.*) The ashes of manure and plants applied to land, are rapidly dissolved by the rains and carried by the descending water into the earth below the point where the roots of growing crops can penetrate. When, on the other hand, these mineral constituents are applied in their natural state of combination with the organic compounds of vegetable and animal manures, they are comparatively insoluble, and are liberated during the slow decomposition of the vegetable matters, in sufficient quantities to supply the wants of the growing crops, and when the decomposition is arrested they are preserved in combination with the organic matters for future use. This fact alone, independently of those which we have just brought forward, should be sufficient to convince the planter of the impropriety of burning his manures and deposits of his forests, and of the error of those who assert that if the mineral elements of plants be supplied, the atmosphere will afford all the other elements necessary to sustain a most luxuriant vegetation.

(*g.*) It is the universal experience of agriculturists that all things being equal, those are the richest soils which contain the largest proportion of organic matters. The alluvial soils of our rice fields and river bottoms, and the virgin soils of the primeval forests, have ever proved the most fertile. As the vegetable mould (the manure of the forests) has vanished under a system of constant culture without manure, so have the yield of the crops diminished. When Massachusetts, Connecticut, New York, Rhode Island, Maryland and Virginia were first settled, the same

exuberant fertility was attributed to the soils of these old States which has since characterized those of Georgia, Alabama, Kentucky, Mississippi, Louisiana, Ohio and Illinois. When this country was first settled, even those portions naturally sterile were covered with a thick deposit of vegetable mould, and yielded for a time abundant crops. Under a reckless and exhausting system of cultivation, this vegetable mould, together with a large portion of the saline ingredients has been consumed, the crops correspondingly diminished, the land reduced to comparative sterility, and the cultivators of the soil driven to seek virgin soil in new and uncultivated regions. From this course, has section after section of the older States, which once yielded an abundant return, been abandoned by their original possessors, and allowed to revert back to the original wilderness. The reckless and ignorant exhaustion of the accumulated vegetable and mineral compounds elaborated and stored up by the vegetation of unnumbered ages, has been one of the prime causes of that mighty tide of emigration from the eastern to the western and south-western States. Under the same system of culture, these States, in turn, will grow old and barren in a century—under this system of reckless and ignorant culture, the original thirteen States grew older and more barren in two centuries than Europe and India and China after thousands of years of cultivation.

We have but to look to our own State to see at once the value of the deposits of forests, and the effects of an ignorant and reckless and grasping system of continuous cultivation, without rest, rotation of crops, or manure.

The lands of middle Georgia, which at the time of their first settlement, were clothed with a dense and magnificent forest, and covered with the accumulated mould of thousands of years, and which yielded most luxuriant and profitable crops of cotton and corn to the early cultivators, who imagined that the soils would last forever without either rest or manure, and without any attention to hill-side ditching and plowing, now present the monotonous and

dreary spectacle of barren red clay hills, barely supporting stunted crops of cotton, struggling to lift its fruit a few inches above the hot and barren ground, and avoid the pelting of the sand, and hardly saving the reputation of the planter from the charge of sanded cotton.

These bald red clay hills, marred by deep furrows and yawning red gullies, and by deserted, dilapidated houses, with their diseased, half dead fruit trees, will long remain monuments of that system of agriculture which has disregarded the value of the vegetable deposits of ages, and which has had for its great object the enrichment of the living generation, regardless of the interests of the future generation.

The same result has followed this system of culture in the southern portions of Georgia. The effects are not so patent to the eye, because the county is level, and because the rivers afford inexhaustible supplies of organic and mineral matters to the rice plantations. It remains to be demonstrated whether or not the fruitful plains of southwestern Georgia, and the fertile valleys of northern Georgia will share the same fate.

(*h.*) Carefully conducted experiments, by intelligent, experienced and unbiased agriculturists, have demonstrated conclusively that something more is needed in agriculture than the mineral constituents of plants. This proposition can be sustained only by the experiments of practical agriculturists, for no matter how plausible and philosophical theories may be, if they are diametrically and irreconcilably opposed to practice, they should be immediately abandoned.

Professor Philip T. Tyson, in his recent report to the House of Delegates of Maryland, thus announces his experience:

"When Baron Liebig's writings gave a fresh impetus to agriculture, more than twenty years ago, public opinion was strongly directed to the importance of acquiring a full knowledge of the constituents of plants. The Baron's teachings tended to produce the belief that the atmosphere would furnish all the organic matters required for plants, if a full supply of each the essential mineral constituents exist in or be supplied to the soil.

"Being at that time a farmer myself, I was much interested with this view of the subject, and lost no time in putting it to the test of experiments. I prepared

a mixture of mineral matters more than that contained in a crop of corn, a crop of wheat, and two crops of clover, according to the best analyses we had at that time. They were applied to several varieties of soil, and the same was done by a friend living at some distance, whose soils differed in many respects from mine. The spaces to which the materials were applied, showed litt e perceptible increase of product. * * Experience has, in my opinion, demonstrated that *very heavy crops cannot be raised during long periods of time without supplying the soil with manures containing at least nitrogen or ammonia* And we may add, also, that if the soil be constantly cultivated, it must be supplied with matters capable of furnishing humus and carbonic acid, in order to produce heavy crops."—*Report to House of Delegates of Maryland, Jan.* 1860,*pp.* 60—61.

In England, this question has received most able and thorough attention at the hands of J. B. Lawes and Dr. J. H. Gilbert.*

These most practical and scientific agriculturists, chose wheat as the type of the cereal crops, turnips as the type of the root crops, and beans as the representative of the Leguminous corn crop, and selected for each of these a field which agriculturally considered, was exhausted, and grew the same description of crop upon the same land, year after year, with different chemical manures, and in each case with one plot or more continuously unmanured, and one supplied every year with a fair quantity of farm yard manure. In this way they devoted 14 acres to the continuous growth of wheat, and 8 acres to the continuous growth of turnips from 1843 to 1851, and 5 to 6 acres to that of Leguminous crops from 1847 to 1851; besides these, they made other field experiments, amounting in each year from 30 to 40 on wheat, upwards of 90 on turnips, and 20 to 30 on beans, and also some on the growth of clover, and some in relation to the chemical circumstances involved in an actual course of rotation, comprising turnips, barley, clover and wheat, grown in the same order in which they are here stated; and in addition to all these experiments, these agriculturists examined the subject of the feeding of animals, viz: Bullocks, sheep, and pigs, and investigated the functional actions of the growing plant in relation to the soil and atmosphere.

*On Agricultural Chemistry—especially in relation to the mineral theory of Baron Liebig. By J. B. Lawes, of Rothamstead, and Dr. J. H. Gilbert. Journal of the Royal Agricultural Society of England, vol. xii, Part 1, No. xxvii, 1851, pp. 1—40.

We believe that the extensive synthetic investigations and experiments of these laborious and conscientious practical agriculturists will command the confidence of this Association.

The following is a condensed view of the most important results obtained by these experiments. In the first experimental season (1844) the field of 14 acres devoted to the continuous growth of wheat, was divided into 20 plots; and mineral manures were employed upon the majority of the plots. The following table will present a summary of the results for 1844:

EXPERIMENTS ON WHEAT—HARVEST OF 1844—SUMMARY.

DESCRIPTION OF MANURES.	Dressed Corn per acre in bushels and pecks.		Total corn per acre in lbs....	Straw per acre in lbs.......
	Bush.	Pecks.		
Plot 3.—Unmanured	16.	0	923.	1120.
" 2.—14 tons of farm-yard manure	22.	0	1276.	1476.
" 4.—The ashes of 14 tons of farm yard manure	16.	0	888.	1104.
" 8.—Minimum produce of 9 plots with artificial mineral manure— Superphosphate of lime, 350 lbs. Phosphate of potassa, 364 lbs.	16.	1	980	1160.
" 15.—Maximum produce of 9 plots with artificial mineral manure— Superphosphate of lime, 350 lbs. Phosphate of magnesia, 168 lbs. Phosphate of potassa, ..150 lbs. Silicate of potassa......112 lbs.	17.	3¼	1096.	1240.
Mean of the 9 plots with artificial mineral manures	16.	3¾	1009.	1155.
Mean of 3 plots with mineral manures and 65 lbs. each of sulphate ammonia	21.	0	1275.	1423.
Mean of 2 plots with mineral manures end 150 lbs. and 300 lbs. of rape cake respectively	18.	1¾	1078.	1201.
Plot 18, with complex mineral manure, 65 lbs. of sulphate of ammonia, and of rape cake 150 lbs.	22.	3¼	1368.	1768.

The following are the most important results established by this series of experiments:

1. The ashes of 14 tons of farm-yard manure produced no increase whatever over the yield of the exhausted unmanured plot; whilst 14 tons of farm-yard manure in its ordinary condition produced an increased yield greater than that produced by the mineral manures, even when mixed with the salts of ammonia.

2. The exhaustion of the land by previous continuous cropping could not have been due so much to the want of mineral constituents, for then some one at least of the nine mineral conditions, supplying in some cases an abundance of every mineral constituent which the plant could require, would have increased the yield.

3. The artificial manures, although liberally supplied in quantities greater than would supply the wants of heavy crops, produced scarcely any increase over the unmanured plots; the average yield of the 9 plots supplied with artificial manures being 16 bushels and 3¾ pecks, whilst the yield of the unmanured plot was 16 bushels—the liberal supply of expensive mineral manures increased the yield only 3¾ pecks per plot.

4. On the other hand the addition to some of these purely mineral manures of 65 lbs. of sulphate of ammonia—a very small dressing of that substance, and containing only about 14 lbs. of ammonia—gave an average produce of 21 bushels; and the small addition of only 300 pounds of rape-cake to these otherwise ineffective mineral manures, increased the yield to 18½ bushels; and, still more striking, the addition of 65 pounds of sulphate of ammonia and 150 pounds of rape-cake, increased the yield to 22 bushels and 3¼ pecks, a greater produce than that obtained by the 14 tons of farm-yard manure.

EXPERIMENTS ON WHEAT HARVEST 1845—SELECTED RESULTS.

DESCRIPTION AND QUANTITIES OF THE MANURE PER ACRE.	Dressed Corn per acre in bushels and pecks.		Total corn per acre in lbs....	Straw per acre in lbs....
SECTION 1.	Bush.	Pecks.	lbs.	lbs.
Plot 3.—No manure	23.	0¾	1441.	2712.
" 2.—14 tons farm-yard manure	32.	0½	1967.	3915.
SECTION 2.				
" 5.—(a.) No manure	22.	2¼	1431.	2684.
" 5.—(b.) Top dressed with 252 lbs. of carbonate of ammonia [dissolved) at 3 times during the spring	26.	3¾	1732.	3599.
SECTION 3.				
" 9. Sulphate of ammonia, 168 lbs. Muriate of ammonia, 168 lbs. } Top dressed at once	33.	1½	2131.	4053.
" 10. Sulphate of ammonia, 168 lbs. Muriate of ammonia, 168 lbs } Top dressed at once	31.	3¼	1980.	4266.

From the yield of the harvest of 1845, just recorded, we see that the highly volatile ammoniacal salt, the *medicinal carbonate of ammonia*, supplied to the soil in solution during the spring, alone raised the produce from 22½ to very nearly 27 bushels; the produce obtained by 168 lbs. of sulphate of ammonia, together with the same quantity of muriate of ammonia, sown all at once, is 33⅜ bushels, being 1 bushel and 1½ pecks more than that yielded by the acre manured,

with 14 tons of farm-yard manure, and 11 bushels more than the produce of the unmanured acre.

EXPERIMENTS ON WHEAT HARVEST 1846—SELECTED RESULTS.

DESCRIPTION AND QUANTITIES OF MANURE PER ACRE.	Dressed corn per acre in bushels and pecks.		Total corn per acre in lbs...	Straw per acre in lbs...
SECTION 1.	Bush.	Pecks.	lbs.	lbs.
Plot 3.—No manure	17.	3¾	1207.	1513.
" 2.—14 tons of farm-yard manure	27.	0¾	1826.	2454.
SECTION 2.				
" 10. (b).—No manure	17.	2½	1216.	1455.
" 19. (a).—Sulphate of ammonia, 224 lbs	27.	1½	1850.	2244.
SECTION 3.				
" 5. (a1).—Ash of 3 loads of wheat straw	19.	0½		1541.
" 5. (a2).—Ash of 3 loads of wheat straw, aud top dressed with 224 lbs. of sulphate of ammonia	27.	0		2309.
SECTION 4.				
" 6. (a.)—Liebig's wheat manure, 448 lbs. } " 6. (b.)—Liebig's wheat manure, 448 lbs. }	20.	1½	1400	1676.
With 112 lbs. each of sulphate and muriate of ammonia	29.	0¾	1967	2571.

"At this third experimental harvest we have on the continuously unmanured plot, namely, No. 3, not quite 18 bushels of dressed corn, as the normal produce of the season; and by its side we have on plot 106, comprising one-half of the plot 10 of the previous year, and so highly manured by ammoniacal salts in 1845, but now unmanured, rather more than 17½ bushels. The near apprcach again, to identity of result from the two unmanured plots, at once gives confidence in the accuracy of the experiments, and shows us how effectually the preceding crop had, in a practical point of view, reduced the plots, previously so differently circumstanced both as to manure and produce, to something like an uniform standard as regards their grain-producing qualitities. We take this opportunity of particularly calling attention to their coincidences in the amount of produce in the two unmanured plots of the different years, because it has been objected against these experiments as already published, that confirmation was wanting as to the natural yield of soil and season.

Plot 2 has, as before 14 tons of farm-yard manure, and the produce is 27¼ bushels, or between 9 and 10 bushels more than without manure of any kind.

On plot 10a, which in the previous year gave by ammoniacal salts alone a produce equal to that of the farm-yard

manure, we have again a similar result: for 2 cwts, of sulphate of ammonia has now given 1850 lbs. of total corn, instead of 1826 lbs., which is the produce on plot 2. The straw of the latter is, however, slightly heavier than that by the ammonical salt. Again, plot 5a, which was in the previous season *unmanured*, was now subdivided: on one-half of it (namely, 5a,) we have the ashes of wheat-straw alone, by which there is an increase of rather more than one bushel per acre of dressed corn; on the other half (5a2) we have, besides the straw ashes, 2 cwts of sulphate of ammonia put on as a top dressing: 2 cwts of sulphate of ammonia have, in this case, only increased the produce beyond that of 5a by 7⅛ bushels of corn and 768 lbs. of straw, which was the increase obtained by the same amount of ammonical salt on 10a, as compared with 10b. It will be observed, however, that in the former case the ammonical salts were top-dressed, but in the latter they were drilled at the time of sowing the seed; and it will be remembered that in 1845 the result was better as to corn on plot 9, when the salts were sown earlier than on plot 10, where the top dressing extended far into the spring. We have had several direct instances of this kind in our experience, and we would give it as a suggestion, in most cases applicable, that manures for wheat, and especially ammonical ones, should be applied before, or at the time the seed is sown; for although the apparent luxuriance of the crop is greater, and the produce of straw really heavier, by spring rather than autumn sowings of Peruvian guano and other ammonial manures, yet we believe that that of the corn will not be increased in an equivalent degree. Indeed, the success of the crop undoubtedly depends very materially on the progress of the underground growth during the winter months; and this again, other things being equal, upon the quantity of available nitrogenious constituents within the soil, without a liberal provision of which, the range of the fibrous feeders of the plant will not be such, as to take up the minerals which the soil is competent to supply, and in such quantity as will

be required during the after progress of the plant for its healthy and favorable growth.

The next result to be noticed is that obtained on plot 6, now also divided into two equal portions designated respectively 6a and 6b. Plot No. 6 had for the crop of 1844 superphosphate of lime and the phosphate of magnesia manure, and for that of 1845 superphosphate of lime, rape-cake, and ammonical salts. For this, the third experimental season, it was devoted to the trial of the wheat manure manufactured under the sanction of Professor Liebig, and patented in this country.

Upon plot 6a, 4 cwts per acre of the patent wheat manure were used, which gave 20¼ bushels, or rather more than 2 bushels beyond the produce of the unmanured plot; but as the manure contained besides the minerals peculiar to it, some nitrogenous compounds, giving off a very perceptible odor of ammonia, some, at least, of the increase would be due to that substance. On plot 6b, however, the further addition of 1 cwt each of the sulphate and muriate of ammonia to this so-called "Mineral Manure," gives a produce of 29¼ bushels. In other words, the addition of ammonical salt to Liebigs mineral manure has increased the produce by very nearly 9 bushels per acre beyond that of the mineral manure alone, whilst the increase obtained over the unmanured plot, by 14 tons of farm-yard manure, was only 9¼ bushels.

If, then, the mechanical form and chemical qualities of the so called 'Mineral Manure,' were at fault, the sulphate of ammonia has, at least, compensated for the defect; and even supposing a mineral manure, founded on a knowledge of the composition of the ashes of the plant, be still the great disideratum, the farmer may rest contented, meanwhile, that he has in ammonia, supplied to him by Peruvian Guano, by Ammoniacal Salts, and by other sources so good a substitute.

In the following table are one or two of the results of the harvest of 1847, which bear upon our question:

Harvest of 1847—*Selected Results.*

Description and Quantities of the Manures per acre.	Dressed Corn per acre in bush. & pecks		Total Corn pr acre in lbs.	Straw per acre in lbs.
SECTION 1.	Bush.	Pecks.	....	....
Plat 3, No. Manure..................	16	3½	1,123	1,902
" 2, 14 tons of farm yard manure....	29	3¾	1,981	3,628
SECRION 2.				
9a1. 1 ton of Rice..................	22	3	....	....
9a2. { Sulphate of Ammonia, 150 lbs Muriate of Ammonia, 150 lbs. }	26	2	....	....
9b. { Sulphate of Ammonia, 150 lbs. Muriate of Ammonia, 150 lbs. }	26	0	....	....

The produce of the continuously unmanured plots is now seen to be almost 17 bushels of dressed corn, and that of the plot with farm-yard manure nearly 30 bushels.

Plots 9a and 9b, the former of which had in the previous season 4 cwts. of rape-cake, and the latter 4 cwts. of rape-cake and 2 cwts. of sulphate of ammonia, with no direct mineral manure in either case since the first season of 1844, where in this, the fourth season, set apart for the trial of some substance rich in carbon (but not so either in nitrogen or in mineral matter,) by the side of pure nitrogenous supply. Thus one-half of 9a (9a1) was manured with *ground rice*, at the rate of one ton to the acre. The other half of 9a (9a2) had 150 lbs. of sulphate and 150 lbs of muriate of ammonia, as also had 9b. The effect of the ton of rice is to give 32¾ bushels of dressed corn, or only 6 bushels more than the unmanured plot; whilst the ammoniacal salts of 9a2 and 9b gave respectively 26½ and 26 bushels. That is to say, with a difference of only half a bushel in the two cases with ammoniacal salts, an average is obtained of 9½ bushels more than on the unmanured plot.

It surely is needless to attempt further to justify, by the results of individual years, our assertion, that in practical agriculture nitrogenous manures are peculiarly adapted to the growth of wheat.

In conclusion, then, if the theory of Baron Liebig simply implies that the growing plant must have within its reach a sufficiency of the mineral constituents of which it is to be built up, we fully and entirely assent to so evident a

truism; but if, on the other hand, he would have it understood that it is of the mineral constituents, as would be collectively found in the ashes of the exported produce, that our soils are deficient relatively to other constituents, and that, in the present condition of agriculture in Great Britain, "we cannot increase the fertility of our fields by a supply of nitrogenized products, or by salts of ammonia alone, but rather that their produce increases or diminishes, in a direct ratio, with the supply of mineral elements capable of assimilation," we do not hesitate to say that every fact with which we are acquainted, in relation to this point, is unfavorable to such a view. We have before stated, however, that if a *cheap* source of ammonia were at command, the available mineral constituents might in their turn become exhausted by their excessive use.

But it is at any rate certain that for wheat, of all our crops, no supply of minerals, phosphates, &c., to the fields of Great Britain generally, will enable it to obtain a sufficient snpply of ammonia from the atmosphere: and, indeed, that any increased produce of it, such as British agriculture (itself so artificial) demands, cannot be obtained independently of an artificial accumulation of nitrogen *within the soil.*"

We might extend this discussion, and cite the experiments of Boussingault and of other practical and scientific agriculturists, sustaining the truth of the views which we have adopted, but such an extension would lead to no other result than a tedious repetition of similar facts, all sustaining these principles which we have shown to be firmly established by the results of careful, comprehensive, practical and philosophical experiments, and based upon immutable facts.

From this discussion we draw the following practical

CONCLUSIONS:

1. The vegetable matters of the soil have most important relations with the growth and perfection of crops—the supply, therefore, of vegetable matters should be preserved undiminished in the soil, by annual additions.

These supplies may be obtained upon every plantation

from these prime sources: first, from the deposits of swamps, and of rivers, from peat deposits, and from the accumulated remains of forests: secondly, from those portions of the crop which are neither consumed nor sent of the place, as the stubble of certain crops and cotton seed: thirdly, from farm-yard manure.

2d. Whatever increases the amount of ammonia in manure, will increase the yield of crops, and especially of grain. We shall in the course of this report point out the manner in which the nitrogenized compounds (ammonia and nitric acid) of manure may be increased and preserved.

3d. Farm-yard manure is the universal food of plants, and furnishes not only the nitrogenized, but also the mineral compounds absolutely necessary to the production of luxuriant crops; and during its slow decomposition in the soil liberates both class of compounds at the times when they are most needed by plants.

4th. The deposits of swamps, the vegetable mould of forests and meadows, the accumulations of peat, the vegetable matters, as stubble and cotton seed not generally consumed upon plantations, and the excrements of animals, should in no case be burned, for the ashes are comparatively valueless for manure.

5th. Fresh bones should not be burned, for a great portion of the value of fresh crushed bones depends upon the organic constituents.

6th. The natural state in which humours, and the various varieties of natural manures are found is the best for the nourishment and perfection of plants. It will, in many cases, be advantageous to hasten the chemical changes of the more stable and insoluble vegetable compounds. The best method of doing this will be discussed hereafter.

7th. Every manure which is composed alone of mineral matters is necessarily partial and imperfect in its action, and should never be relied upon alone.

It is well known that multitudes of the commercial manures belong solely to the class of mineral manures, which are comparatively, even to common farm-yard manure, valueless.

Why should the planters spend millions of dollars for these comparatively worthless compounds, often adulterated, in almost every case sold at exhorbitant prices, and in every case inferior in power to an equivalent application of farm-yard manure?

We will consider in the next place, the native sources of fertility accessible to the planters of Georgia.

CHAPTER XIII.

OTHER SOURCES OF FERTILITY IN GEORGIA.

CHAPTER XIII.

Native Sources of Fertility in Georgia.

The Waters of Georgia—Waters of the Primitive Region—Their Purity and Influence upon Health—Character of the Deposits of the Waters of the Primitive Region. Waters of the Tertiary Shell Limestone—they abound in Carbonate of Lime—Deposits from the Rivers, Streams and Swamps in the Tertiary Lime formation—Influence of these waters upon the health and diseases of the Inhabitants—Importance of employing Cisterns in this region. Waters of the Rivers and Swamps in the South-eastern portion of Georgia—Agricultural value of these River and Swamp Deposits—Influence of these waters upon the health of the Inhabitants—Importance of Cisterns upon Rice Plantations.—Waters of the Atlantic Ocean—Agricultural value of the salts which it contains. Waters of the Cities of Savannah and Augusta—Influence of the waters of these cities upon the health of their inhabitants. Sources of fertility accessible to every Planter—Cotton Seed, analysis of, its value as Manure—Stable Manure—Cowpen Manure—Human Excrements. Plan for the effectual preservation of the valuable ingredients of Manure. Principles which should govern the collection and preservation of the Excrements of Man and Animals and the products of decomposing vegetables.

Water which covers two-thirds of the surface of our globe, and is distributed throughout the atmosphere and soil, exists in similar proportions in the structures of plants and animals and is the great medium of chemical change.

Under the action of heat and gravitation, a great circulation of water is carried on throughout the atmosphere, and over the surface of the continents and islands, which disintegrates and wears down the solid rocks, dissolves and washes away the impurities of the atmosphere and land—

every fountain, every brook, every mountain torrent, and every river, transport these materials, and gradually alter the beds of lakes and seas and oceans, and build up immense deltas and islands and continents.

The structure of the crust of our globe gives unmistakable evidence that in its early history it was a molten mass—when the surface cooled it was composed of nothing but rocks and water, a deadbarren mass, studded with volcanoes and lofty rocks. Geology teaches that at this time no plant or animal existed upon our globe; before animated existence could appear, it was necessary that the solid barren rocks should be disintegrated, worn away, the inequalities of the surface filled up, and the crust of the earth covered by a loose, pulverized soil, suitable for the habitation of plants and animals—this was accomplished by the circulation of the water and air, under the action of heat and gravitation, which at the present day, preserves the purity of the ocean and atmosphere, waters the thirsty earth, supplies the most important elements of the structures of plants and animals, and clothes the surface of the earth with a luxuriant vegetation, which elaborates the materials for the formation and maintenance of all animals, from the simple animalcule to the complicated organism of man.

An analogous lesser circulation of water, whose existence depends upon the great circulation in the inorganic world, is carried on unceasingly through the textures of plants and animals; and water in the organized world, as in the inorganic, is the great medium of change, and the great agent in the removal of disintegrated, chemically altered offending substances.

The amount of water required annually for the circulation through the textures, the distribution of the nutritive materials, and the removal of the waste useless products of the billion inhabitants of the earth, is, at the lowest calculation, fifteen hundred billion pounds; while three thousand billion pounds are required for the accomplishment of similar offices in the animal kingdom; and the vegetable

kingdom, at the lowest calculation, requires annually 9,288,000,000,000,000 pounds, or 4,644 billion tons of water. These facts not only point out the the great importance of an examination of the waters of any country, but they also indicate the various relations in which the Agriculturist should study the waters of a country.

The following are the principle relations in which the waters of different countries should be studied by Agriculturists:

1st. Their relations to past geological changes.

2d. Their relations to present changes, as determined by the comparison of the chemical and physical constitution of the rocks and soils through which the waters percolate and from which they are collected, with the chemical and physical constitution of the salts and suspended matters of the waters.

3d. Their relations to present changes, as determined by the amounts and modes of deposition of the suspended matters.

4th. Their relations to climate.

5th. Their relations to plants and animals through the atmosphere and soil.

6th. Their direct relations to plants and animals in virtue of their chemical constituents.

It is evident that each one of these grand divisions would have many sub-divisions—thus the sixth division would include, besides many other sub-divisions, the most important subject of the relations of the mineral constituents of the waters of springs, wells, streams and rivers, seas and oceans to the health of man.

It is still further evident that the most important art of irrigation must depend for its perfection, and for its scientific and successful application, upon a knowledge of the physical and chemical constitution, and upon the physical and chemical and physiological relations of the waters.

This subject is as vast as it is important, and as no practical attention has been paid to it in Georgia, we must

begin from the very foundation, and endeavor to establish the relations of the waters of Georgia to agriculture, and to the health and diseases of her inhabitants, by careful and laborious investigation.

The investigation, now commenced, will require for its thorough execution, years of laborious research; we must, therefore, defer for the present, the full discussion of the most important subject of irrigation; for it would be idle to recommend the extensive employment of a most expensiye system of agricultural improvement, before the chemical constitution and agricultural capabilities, and topographical relations of the soils of Georgia have been established, and before the climatic relations of the various geological formations, and the physical and chemical characters of the various waters of diverse geological formations have been determined.

Upon the present occasion we will content ourselves with stating some of the most important circumstances which should determine the employment of irrigation.

1st. The character of the water.

Those waters which contain the largest proportion of the salts necessary for the healthy constitution of plants, are within certain limits, the most valuable for irrigation—the sewerage water of towns, as we shall show hereafter, is of great value in irrigation. We say within certain limits, for sea water, which contains many of the salts which enter into the constitution of plants and animals, is too concentrated for any other than a limited and occasional application to land.

2d. The character of the soil.

It is almost the universal experience of agriculturists that the effects of irrigation are not only more immediate, but are also more powerful upon sandy soils.

3d. The climate.

If the atmosphere be sufficiently loaded with moisture and the rain be sufficiently abundant, or if the summers be

short and the winters long and severe, irrigation would be unnecessary.

4th. The supply of water.

If the supply be subject to great alterations, and if, as in many parts of the State of Georgia, it be intermittent, questions would arise with reference to constructing reservoirs for the water, so that it might be in abundance when most needed. In the larger tracts of the level portions of the State, the construction of suitable reservoirs would be almost impossible and in any case the expense would not warrant the undertaking. In many parts of the country dams cannot be thrown across streams and rivers, and especially across swamps, without injuring the surrounding plantations. In many of the swamps and streams in the southern portion of the State, the fall is so small and the course of the water so sluggish, that any obstruction which would permit of a sufficient supply for irrigation would seriously damage numerous plantations.

5th. The structure and elevation of the land.

No two tracts of land and in fact, scarcely two acres in the same tract are alike; and as it is essential for the success of irrigation that the water should not cover the land in any part to any depth, but should flow off continuously, inclined planes are necessary in meadow irrigation, and in every form of irrigation, the levels, lines and angles must be arranged with the greatest care and accuracy.—The preparation of the surfaces of land for irrigation is one of the most difficult operations in agriculture, and demands accurate notions of solid geometry.

6th. The expense of the preparation of the land, and of the elevation and distribution of the water.

The expense of irrigation in England, as we shall show hereafter, has been very great. In Georgia, the expense will depend upon the cost of labor, of the preparation of the land and of the machinery necessary for the elevation and distribution of the water.

7th. The relations of irrigation to the great staples of the South.

As far as our information extends, irrigation has never, in this country, been applied to the cultivation of cotton.

8th. The effects upon health.

I am persuaded that the waters of our swamps, especially in hot, dry seasons, would tend to produce ill health in the operatives. This question is far more important than that of expense or profit.

It would be absurd for any one to recommend the extensive employment of irrigation before these questions were settled.

The waters of Georgia should be studied and classified according to geological, rather than geographical boundaries. In a general survey of the waters of Georgia, we have nine distinct classes of waters, which include many varieties dependent upon chemical and physical variations in different geological strata, deposited during different geological periods.

1st. The waters of the springs, wells, streams, rivers and lakes of the Primitive Region.

2d. The mineral waters of the Primitive Region.

The term primitive is applied to the extensive belt of country that lies between the eastern base of the Blue Ridge and the north-western terminations of the Cretaceous and Tertiary formations, embracing the counties of Rabun, Union, Lumpkin, Habersham, Franklin, Hart, Elbert, Madison, Hall, Forsyth, Gwinett, Jackson, Clarke, Oglethorpe, Wilkes, Lincoln, Columbia, Warren, Hancock, Taliaferro, Greene, Putnam, Jasper, Morgan, Walton, Newton, DeKalb, Henry, Butts, Fayette, Fulton, Cobb, Campbell, Carroll, Coweta, Heard, Troup. Meriwether, Pike, Upson, Monroe, and portions of Gilmer, Cherokee, Cass, Paulding, Talbot, Crawford, Bibb, Jones, Baldwin, Richmond and Crawford.

The rocks of this region of Georgia are chiefly sedimentary, non-fossiliferous, as micaceous, felsphathic and sienitic gneiss, hornblend schist, talcose slate, chloritic slate and other rocks of closely related characters. In several localities, as in DeKalb county, large masses of granite are found. Crystalline Primitive Marble exists to a limited extent in several of the counties in this region, as in Hall and Habersham; it

does not exist, however, in sufficient abundance to exert any marked effects upon the waters of this region.

3d. The waters of the springs, streams, rivers, and lakes of the transition or older fossiliferous formations in the northwestern portions of the State, embracing Cass, Murry, Chattooga, Walker, Dade and Floyd, and portions of Paulding, Cobb, Cherokee and Gilmer counties.

4th. The mineral waters in the older fossiliferous formations in the north western portions of the State.

5th. The waters of the springs, wells, lakes, rivers and swamps of the Eocene Lime formation, lying to the south and south-west of the Primitive and Cretaceous formation, embracing portions of Richmond, Burke, Screven, Effingham, Emanuel, Jefferson, Washington, Laurens, Pulaski, Twiggs, Houston, Bibb, Macon, Sumpter, Randolph, Lee, Baker, Decatur, Dooly, Irwin, Thomas and Lowndes.

6th. The waters of the springs, wells, lakes, streams, rivers and swamps of the Cretaceous formation lying between the Primitive and the Eocene, and embracing the counties of Marion, Muscogee, and portions of Talbot, Harris, Stewart, and Randolph.

7th. Waters of the springs, wells, streams, swamps and rivers of that portion of the tertiary formation which extends from the south, south-western and western boundaries of the eocene lime formation, to the Savannah River and the Atlantic ocean, embracing Effingham, Chatham, Bryan, Tatnall, Liberty, McIntosh, Glynn, Wayne, Appling, Montgomery, Telfair, and Ware.

8th. The waters of the Salt Rivers and of the Atlantic Ocean.

9th.) *The Waters of the Cities and Towns of Georgia.*

These are made a distinct class, because the waters of cities are greatly altered and contaminated by excrementitious matters, and the health of the inabitants, and the prevalence of epidemic and contagious diseases influenced by the condition of the waters.

Upon the present occasion we shall offer observations only upon the 1st, 5th, 7th, 8th and 9th classes, reserving the others for future reports.

Waters of the Primitive Regions of Georgia.

The waters of no part of the world contain less mineral matter in solution than the waters of the Primitive regions of Georgia.

A distinction must be made between the mineral and the suspended matters of streams and rivers. Water may present a turbid muddy appearance from the presence of insoluble suspended matters, and yet be very pure. It is known to every resident of middle Georgia, that the streams and rivers, especially in wet seasons, present a turbid reddish and brownish yellow, and red appearance. This is due to the presence in the waters of the insoluble red clay washed down by the rains.

The following analysis of the Savannah river water opposite Augusta, just at the termination of the Primitive formations of Georgia and South Carolina, which it drains, will afford the best view which we can present, of the average composition of the streams of middle Georgia.

ANALYSIS 32. SAVANNAH RIVER WATER OPPOSITE THE CITY OF AUGUSTA.

September 10th, 1860. Water unusually low—the season had been hot and dry. Suspended matters in 100,000 grains. Grs. 5. The suspended matters are much less than in wet seasons, when the red clay is washed down. These suspended matters were found under the microscope, to consist of particles of black and white mica, fine silicious sand, minute particles of different non-fossiliferous primitive rocks, animalcules and clay colored red by peroxide of Iron. 100,000 grains of water after the removal of the suspended matter contained:

Solid matters		4.2936
Carbonate of Lime, 0.7544.	Lime	0.4225
	Carbonic Acid	0.3319
Carbonate of Magnesia, 0.0250	Magnesia	0.0119
	Carbonic Acid	0.0131
Sulphate of Lime		slight trace.
Chloride of Calcium		slight trace.
Chloride of Maguesium		slight trace.
Phosphate of Lime		slight trace.
Chloride of Sodium, 0.0436.	Sodium	0.0265
	Chlorine	0.0171
Slph'tes of Soda & Potassa, 0.0489.	Soda and Potassa	0.0216
	Sulphuric Acid	0.0273
Silicic Acid, Silicate of Alumina, Silicate of Potassa, Silicate of Soda, together with a small proportion of Organic matter and traces of Ammonia		3.1210

The following analysis, presents as far as my investigations extend, a correct view of the general composition of the waters of the springs of middle Georgia. The Turknett springs from which the sample was taken, may be taken as a type of the springs generally, in the primitive region of Georgia. The waters of the Turknett spring issue from the base of the primitive sand hills near Augusta, which are composed of the following strata: Sand and kaolin; red clay, sand and pebbles, with masses of kaolin; primitive sand-stone (a conglomerate of quartz, mica, horn-blende tourmalin, and kaolin clay;) chloritic slate and quartzose slate; talcose slate; mica slate; gneiss, intersected in some localities with veins of granite. This is the most general arrangement of these high-lands, although not in this exact order or number. In addition to these minerals, in this immediate locality, a small deposit of arragonite in chlorite slate, has been discovered by Mr. William Phillips, the accomplished Civil Engineerof Augusta, near Rae's creek, on a line to the east, (the sand hills run east and west above Augusta,) with the Turknett spring and one mile distant. I have carefully examined this locality, and find that the deposit of arragonite is exceedingly limited in quantity, and from its deposition in thin layers in the cracks and seams, and between the strata of the chloritic slate, and from the size and perfection of the crystals in many parts, has evidently been deposited from water charged with carbonate of lime, percolating through the chloritic slate. The arragonite varies in thickness, from two inches to a mere film, coating the surfaces of the chloritic slate. Crystalline milky quartz is mixed with the arragonite and deposited in a similar manner in the seams and between the strata. This has evidently been deposited in a similar manner from water percolating through the crevices, and between the strata of the chlorite slate. It is probable that the aragonite and the quartz were deposited at the time of the decomposition of the potash and lime felspars, from which the extensive beds of kaolin found in these regions were derived. Near this locality a few small crystals of cubic pyrites have been discovered in the chloritic slate.

A careful examination of the relation of these minerals, and of the water which passes over them, convince me that they could under no circumstances, exert any influence upon the waters of the Turknett spring, for they exist in too small amount to affect to any extent even the waters of Rae's creek, and more especially, because the valley of Rae's creek which receives the waters flowing over these minerals, is separated for one mile by highlands from Turknett spring, and pursues a different direction from the valley of the Turknett spring, and its waters flow in an entirely different direction.

An unsucccssful attempt was made to bore an artesian well in the valley, into which the waters of the Turknett spring flow, some 30 yards below the main fountain—the boring was arrested by gneiss rock, at a depth of 50 feet.

The following is the section of the valley just below the Turknett spring, at the base of the sand hills, which was once covered with a luxuriant vegetation: Sand and organic matter, 1 foot; peat, 2 feet; coarse angular sand, pebbles and kaolin, 12 feet; clay, sand, and pebbles (the clay was chiefly kaolin, and of a finer and whiter character than the preceding,) 34 feet; primitive non-fossiliferous rock at 50 feet beneath the surface, undetermined.

We have mentioned the deposit on Rae's creek for it is the only locality near Turknett spring where any rocks other than the silicates can be found.

The waters of the Turknett spring are perfectly limpid, and have been used by the citizens of Augusta for 25 years for all the purposes of life.

ANALYSIS 33. TURKNETT SPRING WATER. SPRING SITUATED 2 MILES FROM AUGUSTA. SPECIMEN OF WATER TAKEN FROM A HYDRANT IN THE CITY SEPT. 11TH, 1860. SEASON HOT AND DRY. WATERS OF ALL THE NEIGHBORING CREEKS AND RIVERS UNUSUALLY LOW. THE DROUGHT HAD BEEN SO GREAT THAT THE CROPS HAD SUFFERED SERIOUSLY. IT IS EVIDENT THAT SUCH A SEASON IS MOST SUITED FOR TESTING WATER. SPECIFIC GRAVITY BUT VERY LITTLE GREATER THAN DISTILLED WATER.

100,000 grains contain:

Solid residue		3.6282
Carbonate of Lime, 0.2576.	Lime	0.1548
	Carbonic Acid	0.1033
Carbonate of Magnesia, 0.0250.	Magnesia	0.0115
	Carbonic Acid	0.0135
Sulphate of Lime		slight trace.
Sulphate of Magnesia		slight trace.
Sulphates of Soda and Potassa		slight trace.
Chlorides of Sodium and Potassium, 0.0858.	Sodium and Potassium	0.0357
	Chlorine	0.0501
Silicic Acid, and Silicates of Soda and Potassa, held in solution by Carbonic Ac.d, (chiefly Silicic Acid and Silicate of Potassa.)		2.863

This analysis shows not only the great purity of the springs in the primitive region of water, but it also illustrates important geological changes which have been in progression for thousands of years. I allude to the relations of the silicates and silicic acid to the other constituents, and to the extensive beds of kaolin in the primitive region of Georgia, and in the tertiary formation just below the primitive region, and to the occurrence of extensive deposits of silicified shells (Burr Mill stone in the eocene formation,) which, as far as my investigations extend, form the superficial strata of the fossils of the eocene formation, and are overlaid by the joint clay which appears to be closely related in formation, and chemical constitution and geological age, with the kaolin clays just below the primitive formation, which have resulted in some former time from the decomposition of eurite and felspar.

In the waters of this spring we have proofs that the decomposition of felspathic minerals is still progressing, and that certain elements of this decomposition can be transported in the waters, suspended by carbonic acid-gas. It seems but reasonable to suppose that the silicate of alumina resting upon the eocene shell formation (joint clay,) was derived from the same sources as the beds of white kaolin clay, and that the silica which permeated and transformed the shells of the upper portions of the eocene fossils, was liberated at the same time. These facts are important in pointing out the geological age of the kaolin beds.

These examinations establish the great purity of the waters of the primitive region of Georgia, and demonstrate that they are suitable for irrigation.

It is to the purity of its waters as well as to the salubrity of

its climate, and the freedom of the soil from vegetable matters that middle Georgia owes its reputation for health. A comparison of the mortuary statistics of this part of Georgia, with the southern and north-western regions, not only establishes its pre-eminence in healthfulness over the cretaceous, tertiary and older fossiliferous formations of Georgia, but also establishes the fact that its inhabitants both white and black, are as healthy and as long lived as the most favored people in the world.

Waters of the Tertiary Lime Formation of Georgia.

a. *Waters of the Springs issuing out of the Shell Limestone of the Eocene.*

We have before alluded to the fact that streams of water frequently issue out of the sides of the hills composed of shell limestone, and we have described the subterranean passages formed by these streams in the shell limestone.

The volume of these streams varies greatly, in some instances it is sufficient to turn more than a dozen mills within 300 yards of the orifices of the subterranean streams.

The following analysis will present the general composition of the water. The waters for these analyses were selected from characteristic springs.

ANALYSIS 34.—Waters of Limestone Spring, 5 miles from the Central Railroad, in Burke county.

	1 gallon of 70,000 grains contain grains.	100,000 grains contain grains	100 gallons contain grains
Solid Residue	15 0260	21.4658	1502.
Carbonate of lime	13.2678	18.9540	1326.
Lime in carbonate of lime	7.4295	10.6137	742.
Carbonic acid in carbonate of lime	5.8365	8.3393	583.
Carbonate of magnesia	0.0756	0.1080	7.56
Sulphate of lime	faint trace	....	....
Sulphate of potassa	no trace.	....	....
Sulphate of soda	no trace.	....	....
Sulphuric acid	trace.	....	....
Silicic acid	trace.	....	....
Carbonate of iron	no trace.	....	....
Chloride of Sodium	0.4878	0.6964	48.78
Chlorine in chloride of sodium	0.2956	0.4224	29.56
Sodium in chloride of sodium	0.1918	0.2740	19.18
Carbonates and silicates of soda and potassa	1.1237	1.6053	112.37

ANALYSIS 35.—*Waters of a Limestone Spring,* 12 *miles from Waynesboro, Burke county, Ga., which issues out of the base of a hill composed in great measure of Shell Limestone.*

As is usual with such springs, the basin is formed of white sand and particles of shells and echinoderms. As the water boils up, these particles of sand and shell are continually thrown up, producing a boiling appearance. The waters of this, and in fact of all similar springs in the eocene formation of Georgia, which I have examined, are perfectly transparent, and as the stranger approaches the stream, it is difficult to persuade himself that there is any water in the stream before him. They resemble in transparency the waters of the celebrated springs in Florida.

In the summer season the waters are deliciously cool and inviting, but they are said to quench thirst imperfectly; and if drank continuously, will first increase the appetite greatly—during this increase of appetite, the patient gains flesh; after several months or a year, however, the bowels become torpid, and the complexion indicates derangement of the liver. Those plantations upon which these waters are used by the negroes, are said to be much more subject to climate diseases, and to exhibit much higher bills of mortality, especially amongst the young, than those upon which rain water, or water which has simply percolated through the joint clay, is used. A most intelligent, practical and extensive planter of Burke county, informed me that since the abandonment of his limestone springs and wells, and the substitution of rain water, collected in cisterns, disease had diminished at least four-fifths amongst his servants and in his family.

100,000 grains contain:

Solid residue		22.649
Carbonate of lime 21.467	Lime	12.022
	Carbonic acid	9.445
Carbonic acid combined with water, but which escaped during evaporation,		9.445
Carbonate of magnesia 0.243	Magnesia	0.116
	Carbonic acid	0.127
Sulphate of lime		slight trace
Sulphuric acid		trace
Sulphate of magnesia		no trace
Silicic acid		trace
Silicate of potassa and soda		trace
Chloride of sodium 0.873	Sodium	0.343
	Chlorine	0.530

If we compare this analysis with the previous one, we observe a slight difference in the amounts, but not in the character of the constituents. They are both rich in carbonate of lime, and almost entirely devoid of carbonate of magnesia and the sulphates. These facts are readily explained by instituting a comparison between the chemical constitution of the waters and the shell limestone formation through which they have percolated. In this formation lime abounds, whilst magnesia exists in comparatively small quantities. The presence of chlorine in these waters is due in part to their marine origin. From the greater solubility of the chlorides, they have been far more rapidly removed than the carbonates, and little more than a trace remains, where formerly, in past ages, when the deposit was first upheaved from the oceans bed, immense quantities existed.

The abundance of carbonate of lime in these waters, and the absence of all noxious compounds, indicate their great value in agriculture.

The great value of these waters in irrigation may be still farther illustrated by the composition of the deposits of swamps through which these waters flow. The samples of swamp deposits, the analyses of which are given below, were carefully selected by myself from the bed of a stream in Burke county, which issued out of the limestone hills, and in the course of a few hundred yards attained a volume sufficient to turn several mills. The preceding analysis represents the composition of these waters :

Swamp Deposits impregnated with Carbonate of Lime from the waters issuing out of the surrounding Shell Limestone hills.

	No. 1.	No. 2.	No. 3.
	Argillaceous swamp deposit—100 parts contain.........	Black swamp deposit—100 parts contain.........	Dry swamp deposit—100 parts contain.........
Carbonate of lime.............................	9.739	2 083	6.808
Lime in the carbonate of lime.........................	5.454	1.167	3.813
Carbonic acid in the carbonate of lime...............	4.285	0.916	2.995
Carbonate of magnesia..............................	0.030	0.009	0.029
Phosphate of lime..................................	0.615	0.292	0.822
Lime in the phosphate of lime........................	0.332	0.158	0.444
Phosphoric acid in the phosphate of lime............	0.283	0.134	0.378
Sulphate of lime.....................................	trace	trace	trace
Chlorides of soda, potassa and magnesia..............	0.120	....	....
Organic matters. { Ulmic acid.........; Humic acid.........; Crenic acid, undecayed vegetable matters, anamalcules, &c.............. }	1.398	2.912	8.221
Silicates insoluble in hydrochloric acid...............	32 190		
Silicious sand...	47.173	28 409	80 211
Alumina and oxide of iron............................	1.140	1.329	3 766
Water as moisture....................................	6.628	64 714	

Finally, we need no greater proof of the agricultural value of these deposits than the size and luxuriance of the dense forests which grow in the course of these streams, and the rank vegetation which grows in the lakes formed by these waters.

b. *Waters of the Wells of the Shell Limestone of the Eocene formation of Georgia.*

The waters of the wells in the eocene formation of Georgia, will vary with their depth, and with the character of the strata from which the waters are collected. Thus, if the strata of joint clay be thick, and the well does not pass through this strata, the water will be comparatively pure. As we have before shown, the joint clay contains relatively but a very small proportion of carbonate of lime, and is

composed almost entirely of insoluble silicates. The waters of wells sunk in the shell limestone, will differ in no essential respect from the waters of the limestone springs. The following analyses will substantiate these statements:

Analysis 36.—Well water from well 55 feet deep, in strata of joint clay 58 feet deep. July 4th, 1860. Hot and dry weather—all the streams and wells were low. Many of them in Burke county were entirely dry. This well was situated in Burke county, 7 miles from the 90 mile station C. R. R.

100,000 grains contain:

Solid residue		13.840
Carbonate of lime 12.960	Lime	7.258
	Carbonic acid	5.702
Carbonate of magnesia 0.015	Magnesia	0.008
	Carbonic acid	0.007
Chlorides of sodium and calcium and magnesium 0.826	Sodium, calcium aad magnesium	0.349
	Chlorine	0.477
Sulphates of soda and potassa 0.002	Potassa and soda	0.0001
	Sulphuric acid	0.0001
Sulphate of lime		no trace
Silicic acid		trace
Silicates of potassa and soda		traces

Analysis 37. Waters from a Well in the Shell Limestone Eocene formation in Burke County Georgia, July 4th, 1860. hot and dry season. Waters of this Well were unually low.

100,000 Grains contain;

Solid Residue		35.738
Carbonate of Lime, 34.492	Lime	19.316
	Carbonic Acid	15.176
Carbonic Acid holding the Carbonate of Lime in solution in the water, but escaping during evaporation,		15.176
Carbonate of Magnesia, 0.424	Magnesia	0.202
	Carbonic Acid	0.222
Chlorides of Calcium and Sodium, 0,601,	Calcium, Sodium	0.230
	Chlorine	0,370
Silicic Acid		trace
Sulphate of Lime		no trace
Sulphuric Acid		slight trace

The injurious effects of the waters of these wells which penetrated the Shell Limestone formation may be illustrated by a simple calculation: at least 17 grains of Carbonate of Lime would be consumed by an adult laborer, daily during the hot weather of summer. This Lime would meet with various acids as acetic and hydrochloric acids in the stomach, and be converted into acetates and chlorides, which

independently of their diuretic and irritant action upon the animal economy, must derange the chemistry of digestion and nutrition, and by these actions, lay the system open to disease.

(*C.*) WATERS OF THE LAKES OF THE EOCENE LIMETSONE FORMATION OF GEORGIA.

The character of the waters of the lakes will depend upon their origin, and upon the character of the sides and bottoms of the lakes. If the waters of the lakes issue out of the shell-limestone, the waters will be impregnated with lime.

If the waters be derived from the joint clay, and if at the same time the bottom and sides of the lake be formed of joint clay or of any other clay in which lime exists in no larger proportion than from one-half to three per cent., then the waters will be pure, suitable for drinking (provided there be not too much vegetable matter,) and the proportion of the lime will be very small.

The planter in determining whether the waters of a lake are suitable for his cattle, must examine into the sources of the water and the character of the bottom of the lake.

The chemical composition of the lake water derived from the shell limestone formation does not differ from the composition of the waters of limestone springs and wells sunk in the limetone formation, and hence it is unnecessary to present analyses of the waters of such lakes.

The other proposition, however, needs confirmation. The following analysis will substantiate the proposition, that the waters drained from the joint clay are comparatively free from Carbonate of Lime.

ANALYSIS 38. WATERS OF A LAKE IN BURKE COUNTY—ONE MILE IN LENGTH AND ONE SIXTH OF A MILE IN BREADTH—WE APPLY THE TERM LAKE TO THIS SMALL SHEET OF WATER, BECAUSE IT IS THE MODE IN WHICH SUCH SHEETS OF WATER ARE DESIGNATED IN THE TERTIARY FORMATION IN GEORGIA.

100,000 grains contain;

Solid Residue	2.1468
Carbonate of Lime, 0,6690,	Lime 0.3190 Carbonic Acid 0.2500
Carbonate of Magnesia, 0.015.	Magnesia 0.008 Carbonic Acid 0.007

Sulphate of Magnesia		no trace
Sulphate of Lime		no trace
Sulphuric Acid		slight trace
Silicic Acid,		trace
Chloride of Sodium and Potassium, 0.451,	Sodium and Potassium	0.186
	Chlorine	0.265
Sulphate of Soda		no trace
Sulphate of Potassa		no trace
Organic Matters		0.998

The establishment of the purity of these lakes which derive their waters from the joint clay is important in its relations to the raising of stock.

From this analysis we see that this lake water is purer even than the Savannah River, and Turknett spring waters.

I need scarcely add that thes waters would be suitable for irrigation, and that it would be far more wholesome to drink such water than that of the Limestone springs and wells. With reference to the organic matter in the waters of the lakes they may be entirely precipitated by adding a small quantity of powdered alum and allowing the coagulated organic matters to settle.

(*d*) *Waters of the Streams and Rivers in the Eocene Formation of Georgia.*

Those streams which derive their waters chiefly from the Shell-Limestone formation, contain much carbonate of lime in their waters; while those streams which are supplied with water from the sand and clays resting upon the Shell-Limestone formation are remarkably pure, and do not contain a much larger proportion of carbonate of lime than the streams of the primitive region. The rivers which flow through the Eocene formation do not contain as much carbonate of lime, as we would suppose, for two reasons:

1st. Their waters are derived chiefly from the highlands of the primitive belt.

2d. Over large tracts of the Eocene formation through which they flow the joint clay varies in thickness from 10 to 60 feet, and their waters are therefore derived chiefly from this strata, which, as we have demonstrated in a former chap-

ter, by analysis, contains little more carbonate of lime than soils derived from primary rocks.

We have before, in analyses 34 and 35, presented the composition of the waters of the streams issuing out of the Shell Limestone, and it will be necessary only to substantiate the the proposition that the larger streams and rivers are not so strongly impregnated with carbonate of lime, and in fact are comparatively purer. The establishment of this fact is important in its bearing upon the use of these waters for both man and beast.

We have selected Buck Head Creek, which drains a large body of land in Burke county, as a type of the streams in the Eocene formation of Georgia.

Analysis 39. Waters of Buck Head Creek, 12 miles from Waynesboro. July 3d, 1860. Season unusually hot and dry. The analysis will represent the waters of Buck Head Creek in their most concentrated state. Waters clear, with little suspended matter.

100,000 grains contain :

Solid Residue		6.067
Carbonate of Lime, 5.346	Lime	3.106
	Carbonic Acid	2.440
Carbonate of Magnesia, 0.029	Magnesia	0.014
	Carbonic Acid	0.015
Sulphate of Lime		no trace
Sulphate of Magnesia		no trace.
Sulphate of Soda		no trece.
Sulphate of Potassa		no trace.
Sulphuric Acid		very slight trace.
Silicic Acid		trace.
Chlorides of Sodium and Potassium, 0.452	Sodium and Potassium,	0,187
	Chlorine,	0.265
Organic matters		——

We have in the waters of Buck Head Creek only 5 1 2 grains of Carbonate of Lime in the 100,000 grains, or less than four grains in the gallon of water; whilst in the streams and wells of the Shell Limestone formation, we have from 10 to 30 grains of Carbonate of Lime to the gallon.

The only advantage for drinking purposes which the waters of the Limestone springs and wells could have over the waters of the streams and rivers is the absence of organic matters. We have before mentioned that these may be removed from

the drinking waters by filtration, or by the employment of a solution of Alum in exceedingly small quantities.

ANALYSIS 40. Waters of the Ogeechee River, near the 90 mile Station, C. R. R., between Emanuel and Burke counties. July 5th, 1860. Season hot and dry.—Waters of River very low.—Most favorable time for determining the characteristic properties. Waters of a greenish tint.—Comparatively, with other river water very clear. Upon standing let fall a light yellow deposit of joint clay and animalcules and organic matters.

100,0000 grains contain:

Solid Residue		6.011
Carbonate of Lime, 4.192	Lime	2 348
	Carbonic Acid	1,844
Carbonate of Magnesia, 0.211	Magnesia	0.101
	Carbonic Acid	0.110
Sulphate of Lime		slight trace.
Phosphate of Lime		slight trace.
Chloride of Sodium, 0.830	Sodium	0 326
	Chlorine	0.504
Sulphate of Soda and Potassa, 0.007	Soda and Potassa	0.0034
	Sulphuric Acid	0.0036
Silicic Acid		——
Vegetable Matters with traces of Ammonia		0.689

This analysis of the waters of the Ogeechee River, at a time most favorable to test its purity, establishes the fact that it is suitable for all the purposes of life. We would, at first sight, suppose that the waters of this River, which flows through the Eocene Lime formation, would be loaded with Carbonate of Lime. The purity of the waters and the small per centage of Carbonate of Lime is readily explained when we consider that the great body of the waters of the Ogeechee are derived from the primitive regions of Glascock, Warren, Taliaferro, Hancock and Greene counties.

We shall hereafter present facts to show that it is highly probable that the waters of the Shell Limestone formation are discharged by subterranean passages into the Atlantic Ocean, and do not, therefore alter materially the chemical constitution of the waters of the large rivers of Georgia, which, without exception, take their rise in the highlands of the great primitive belt.

The following table will present a comparative view of the

chemical constitution and relations of the waters and formations of the Eocene Strata of Georgia:

Table 41. *Relations of the Waters and Strata of the Eocene Formation of Georgia.*

NAME AND LOCALITY.	Carbonate of Lime..	Carbonate of Magnesia	Sulphate of Lime...	Chlorides.........	Oxide of Iron and Alumina.	Silicates..........	Silicic Acid.........	Organic Matters....	Phosphate of Lime, &c.
SHELL LIMESTONE, 1,00 parts.									
Compact White, near Tennille	92.4	trace	0.3	0.015	trace	4.50	0.933	.....	0.623
" " Burke County	87.74	0.770	0.103	0.005	0.266	4.552	4.062	.....	0.933
" " " "	71.93	0.028	0.001	0.005	1.248	19.062	5.46	.....	0.426
" " " "	80.07	0.009	0.004	0.009	0.694	4.018	13.081	.....	1.181
" " " "	85.289	2.220	trace	0.019	0.876	0.393	10.708	.....	0.250
LIMESTONE SPRINGS, 100,000 parts.									
4 miles from C. R. R., Burke County	13.26	0.075	trace	0.487	trace	1.12	trace	.....	.....
16 miles from Waynesboro, Burke County	21.46	0.243	trace	0.873	trace	trace	trace	.....	.....
SWAMP DEPOSITS IMPREGNATED WITH CARBONATE OF LIME FROM LIMESTONE SPRINGS, 100 parts.									
Argillaceous Swamp Deposit, Burke County	9.73	0.030	trace	0.120	1.140	32.19	47.17	1.39	0.61
Black Swamp Deposit	6.80	0.029	trace	.....	3.76	80.21	......	8.24	0.822
WATER OF SHELL LIMESTONE WELLS, 100,000 parts.									
Well 55 feet deep, in Joint Clay, two feet from Shell Limestone, Burke County	12.96	0.015	.....	0.826	trace	trace	trace	.....	.....
Well 60 feet deep in Shell Limestone	34.49	0.424	.....	0.601	trace	trace	trace	.....	.....
JOINT CLAY, 100 parts.									
White Joint Clay, Burke County	0.501	trace	trace	0.050	6.398	54.17	30.7	.....	7.70
Green Joint Clay, " "	1.700	0.600	0.060	0.090	10.517	71.672	......	.....	1.343
WATERS DERIVED FROM THE CLAYS OF THE EOCENE FORMATION, 100,000 parts.									
Lake, Burke County, Ga.	0.569	0.015	.....	0.451	trace	trace	trace	0.998	.....
MARLS DERIVED FROM SHELL LIMESTONE AND JOINT CLAY, 100 parts.									
Green Marl, Burke County	43.43	0.270	trace	0.014	7.196	31.94	8.055	.....	3.649
Yellow Marl, " "	43.02	0.841	0.002	0.010	0.265	40.178	5.620	.....	6.465
Reddish Brown Marl, Burke County	42.38	0.157	trace	trace	2.265	23.346	22.900	.....	0.215
" " " " "	15.47	trace	trace	0.086	2.005	42.662	16.942	...	0.348
" " " " "	10.79	trace	trace	0.107	2.565	54.594	21.680	.....	0.446
WATERS DERIVED FROM JOINT CLAY SHELL LIMESTONE AND MARL AND SRUFACE SOIL, 100,000 parts.									
Buck Head Creek, Burke County	5.546	0.029	.....	0.452	.....	.....	.....	.....	.....
WATERS DERIVED FROM THE PRIMITIVE FORMATION OF MIDDLE GEORGIA, SHELL LIMESTONE, MARLS, JOINT CLAYS, OTHER CLAYS AND SURFACE SOIL.									
Ogeechee River, Burke and Emanuel counties	4.192	0.211	trace	0.830	trace	trace	trace	0.689	

Waters of the Tertiary Plain lying between the southern and eastern boundaries of the Eocene Formation.

Waters of Swamps.

In the level plain which extends up from the Atlantic ocean, from 30 to 60 miles, there are numerous swamps which discharge their waters into short, deep, sluggish streams, in most cases surrounded by extensive swamps and marshes. The tide flows nearly to the sources of these rivers, and during dry weather, the tides sometimes penetrate for a considerable distance into the deepest swamps.

These swamps increase in breadth from their junction with the rivers, and interlocking with each other form a chain across Georgia and Carolina, several hundred miles in length, parallel with the sea coast.

This low plain with its extensive swamps, is bounded by elevated lands called the Sand Hills. The rise from the Atlantic ocean to the ancient sea beach which forms the commencement of these elevated lands, is not more than from 10 to 30 feet, whilst the elevation of the second plain varies from 50 to 100 feet above tide water.

This elevated plain continues back from 50 to 70 miles, when it is in turn bounded by another escarpment, or ancient sea cliff running nearly parallel with the lower sea margin. Beyond this ancient sea beach we have another extensive plain, which gradually rises to the primitive region.

The dry land, of the first plain, suitable for the cultivation of corn and cotton, is composed in large measure of sand, with varying admixtures of red and yellow clays, forming a rich loose soil, containing much organic matter, easily penetrated by the roots of vegetables, and supporting dense forests and cane-breaks.

The soil of the river bottoms, and swamps and marshes, consists of a rich black deposit of vegetable matter, mixed with varying proportions of sand and clay, sometimes alternating with beds of marl and sand—this clay deposit varies in depth from 5 to 13 feet, and rests upon sandy formations which have been referred to the Post Pliocene—this last formation, contains, buried deep beneath the present forests the stumps of pines, cypress, cedar and oak, and other trees, and affords evidence of successive elevations and depressions of the coast.*

The second great plain is covered chiefly by forests of the long leaf pine, and the surface soil is composed chiefly of

*The occurrence of stumps of trees at various depths beneath the surface, was first noticed by William Bartram, in his "Travels through North and South Carolina, Georgia, and East and West Florida;" the phenomenon was, however, first satisfactorily explained and the successive elevations and depressions of the coast demonstrated by the distinguished Naturalist of Georgia, Dr. James Hamilton Couper, of St. Simons Island.

sand, with little vegetable matter, resting upon beds of clay and these again upon sand. The depth of the upper layer of sand varies greatly—it is deepest at the southern boundary of the plain—I have seen wells 30 and 40 feet in depth, which passed through nothing but pure sand.

It is from this plain that the swamps chiefly derive their waters—the examinations of the waters of these swamps should commence, therefore, with the streams which form in this plain, and should progress down to the sea-coast.

This is the method which we have pursued, and we will now present the results of our investigations.

ANALYSIS 41. WALTHOURVILLE BRANCH WATER FROM THE SAND HILLS IN LIBERTY COUNTY, GEORGIA, 35 MILES FROM THE ATLANTIC OCEAN.

The weather had been hot and dry, and all the smaller streams flowing into the swamp from the highlands of the second plain, had been dried up, this specimen therefore, selected during hot weather, May 27th, 1860, should present all the marked characteristics of the head waters of these swamps. In mass these waters presented a deep reddish color, like port wine; in thinner masses as it flowed over the white sandy road, it presented a rich golden color with a shade of red. In glass vessels it also presented a golden color. The color is dependent upon the vegetable matters in solution and varies with the amount of water which falls in the form of rain. After standing, a very slight, light deposit fell, which under the microscope, was found to consist of vegetable cells and living animalcules, which differed in character from those of the rivers. The amount of this deposit did not exceed the 20th of a grain to the gallon. The waters were perfectly transparent.

Specific gravity.................................1000.081

100,000 parts contain:

Solid residue		4.000
Carbonate of Lime, 0.333.	Lime	0.187
	Carbonic Acid	0.146
Carbonate of Magnesia, 0.057.	Magnesia	0.030
	Carbonic Acid	0.027
Sulphate of Lime		no trace.
Phosphate of Lime		no trace.
Silica		trace.

Chloride of Sodinm, 0.346.	Sodium	0.136
	Chlorine	0.210
Sulphates of Soda and Potassa, 0.493.	Soda and Potassa	0.230
	Sulphuric Acid	0.263
Alumina		trace.
Oxide of Iron		trace.
Organic and Volatile matters with traces of Ammonia,		2.300

This analysis reveals the purity of these waters. During wet seasons the amount of solid matters, which in the most concentrated state are less than three grains to the gallon, will be but little greater than the solid residue of rain water.

ANALYSIS 42. SWAMP WATER FROM THE CHANNEL OF A DEEP SWAMP, IN LIBERTY COUNTY, INTO WHICH THE WATERS, THE ANALYSIS OF WHICH WE HAVE JUST RECORDED, EMPTY.

This sample of water was selected 7 miles below the point where the previous sample was obtained, and 10 miles above the junction of this swamp with the north Newport River, May 27th, 1860. The season had been hot and dry, and the waters of the swamp had been very low, and confined almost entirely to the deep channel.

After standing, a heavy dark brown deposit consisting of animalcules, vegetable matters and silicate of alumina, with various salts, as phosphate of lime and magnesia covered the bottom of the glass vessel, and the waters became transparent and presented a greenish yellow color.

Specific gravity.................................1000.1052

100,000 grains contain:

Suspended matters		3.240
Solid residue		10.000
Carbonate of Lime, 2.675.	Lime	1.496
	Carbonic Acid	1.179
Carbonate of Magnesia, 0.487.	Magnesia	0.232
	Carbonic Acid	0.255
Sulphate of Lime		trace.
Phosphate of Lime		trace.
Chloride of Calcium		trace.
Sulphate of Magnesia		trace.
Phosphate of Magnesia		trace.
Sulphate of Magnesia		trace.
Phosphates of Soda and Potassa		trace.
Chloride of Sodium, 0.845.	Sodium	0.315
	Chlorine	0.530
Sulphates of Soda and Potassa, 0.663.	Soda and Potassa	0.309
	Sulphuric Acid	0.354

Silicic Acid,
Alumina,
Oxide of Iron,
Organic and Volatile matters containing traces of Ammonia. } 5.010

ANALYSIS 43. STAGNANT SWAMP WATER, ARCADIA SWAMP, LIBERTY CO., 8 MILES FROM ITS JUNCTION WITH THE NORTH NEW PORT RIVER, JUNE 1ST, 1860.

Water taken from a deep basin in the large canal which drains the rice-fields: the swamp was entirely dry with the exception of the deeper portions of the canal, the waters of which had ceased to flow for at least three months, the season having been unusually warm and dry. The fish, terrapins, frogs, alligators, and snakes had all collected in these pools of stagnant water. Many fish had died in these pools of stagnant water, and the living catfish kept their mouths and feelers upon the surface of the water. As the eye rested upon the black and green, turbid waters, scarcely a spot could be discovered, not occupied by the mouths and feelers of catfish moving tremulously about upon the surface of the water like so many large spiders; in fact, upon a general view these pools, resembled a dark surface of black and green liquid mud, upon which thousands of large spiders were dancing. Every now and then, the monotony would be broken by the splash of a mudfish or garfish, or conger eel, or the plunge of a bullfrog. The catfish appeared in their distress, and anxiety to absorb the oxygen from the atmosphere, to disregard alike the presence of man, and of the moccasins and water snakes which sluggishly moved in the stagnant pools, amongst their feelers, apparently satiated and disgusted.

These stagnant pools, and in fact the whole swamp, under a burning sun emitted a most sickening and disgusting stench. Exposure to this atmosphere, contaminated with the gases arising from the decomposition of vegetable and animal waters, during the heat of the day from 10 o'clock in the morning until 3 o'clock in the afternoon, obtaining specimens of water and capturing the cold-blooded reptiles, was followed before night by an active diarrhœa.

1 have before suffered in a similar manner from exposure to these swamps in the summer season. Sulphate of Quinia taken upon the appearance of the first symptoms of lassitude and of undue action of the bowels, was the means of relieving the unpleasant effects of this exposure in two days; and I have upon other occasions, when I have been similarly exposed, in the prosecution of my inquiries experienced beneficial effects from Sulphate of Quinia used as a prophylactic.

The power which Quinia possesses of averting an attack of malarial fever, is most valuable to the planters of these regions, who are often during the harvesting of Rice, necessarily exposed to the deleterious effluvia of the swamps.

That the diarrhœa was caused by the effluvia of these swamps inhaled during the collection of the waters and samples of the swamp mud, and of the natural history, specimens was proved by the fact that my servant man (a strong healthy negro who resided upon the plantation one mile from this swamp,) who assisted in procuring the specimens, was also attacked at night with diarrhœa.

I was anxious to test the effects of these waters when absorbed directly into the blood. They were placed in bottles, hermetically sealed, and upon my return to Augusta two days after, I injected several fluid ounces into the subcutaneous tissue of a large Newfoundland dog. The water was injected into the subcutaneous tissue of the back and right fore and hind-legs. At the time of the injection the water had the same sickening smell of the swamp.

No special symptoms were induced by the injection of the water, at the time; but upon the next day, there was a slight rise in the temperature of the dog, and the parts upon the back and legs where the swamp water had been injected were greatly swollen.

Upon the third day the parts were lanced, and discharged much green and yellowish green, exceedingly offensive matter, together with much most foul and fetid air. The parts

continued to discharge large quantities of foul matter and air for ten days. Tar was applied liberally around, and within the orifices of the abscesses, to keep away the flie s, which would I am confident have destroyed the dog. The dog lost flesh to a considerable degree, but recovered entirely in three weeks.

At the end of one month he was killed by the subcutaneous injection of acetate of morphia, and a careful examination with the naked eye and with the microscope was made of all the viscera: no lesions of the organs were discovered, and no alterations of the viscera were manifest, the color of the liver was natural, and the spleen was not enlarged.

The swamp water was not injected directly into the blood-vessel system for I felt confident that the animalcules and suspended matters which could not be removed by filtration would have produced death by interfering with the capillary circulation in the lungs, independently entirely of any direct poisonous effects.

The highly complex nature of these waters will be seen in the following analysis:

Specific gravity,	1000 661
Solid residue in 100.000 grains	23.400
Suspended matters " "	100.000

100,000 grains contain:

Suspended matters, 100. grains.	Phosphates of Lime and Magnesia, 22.224,	Phosphoric Acid	13 958
		Lime and Magnesia	8.266
	Chlorides of Sodium, Potassium, Calcium and Magnesium. Sulphates of Soda, Potassa, Lime and Magnesia. Phosphates of Soda and Potassa.		5.733
	Organic matters; Animalcules; Microscopic Plants; Decaying, vegetable and animal matters; Urea, Uric Acid; Salts of Ammonia; Crenic, Apocrenic and Humic Acids		15.101
	Silicates of Alumina, Potassa and Lime, Silicic Acid, Peroxide of Iron,		56.892

Gases.	Sulphuretted Hy'rogen 3.488,	Sulphur	3.283
		Hydrogen	.205
	Phosphuretted Hydrogen,		
	Carburetted Hydrogen,		
	Carbonic Acid Gas,		
	Carbonic Oxide Gas,		
	Atmospheric Air,		
	Oxygen,		
	Nitrogen.		
	other undefined gases.		
Solid Residue, 23.400,	Carbonate of Lime, 3.122,	Lime	1.487
		Carbonic Acid	1.635
	Carbonate of Magnesia, 0.455,	Magnesia	0.217
		Carbonic Acid	0.238
	Chlorides S'd'm & P'm, 2.946,	Sodum & Potassium	1.350
		Chlorine	1.596
	Sulp'ts Soda & Potassa, 4.223,	Soda and Potassa	2.050
		Sulphuric Acid	2.173
	Silicic Acid		0.213
	phosphates of Soda, Potassa, Lime & Magnesia		trace.
	Chlorides of Magne'sm, Calci'm & Aluminium		trace.
	Organic Matters, Humic, Ulmic, Crenic & Apocrenic Acids, Animalcules, Microscopic Plants, Ammonia, Urea, Uric Acid, Urate of Ammonia, Putrefying vegetable & Animal matters, Undefined vegetable & Animal matters.		2.450

ANALYSIS 44. STAGNANT SWAMP WATER TAKEN FROM A STAGNANT POOL IN THE SAME SWAMP AND UPON THE SAME DAY WITH THE PRECEDING SPECIMEN.

This stagnant pool was in the south edge of the deep wooded swamp, from the north edge of wnich the preceding specimen was selected. This pool was much more shallow than the preceding one, and was also not connected with the main canal which drains the swamp. Waters of a black opaque muddy appearance. As in the former case, the cat-fish had covered the surface with their mouths and feelers. The fish appeared to have died out more completely, and decomposition appeared to have progressed much more rapidly in this pool than in the preceeding one. This was due to the far smaller size and less depth than the former. During

droughts, the catfish stand the drying up and contamination of the water, much better than the perch, and other small scale fish, whilst the gar and mudfish, which have both gills and lungs, stand the drought much better than the catfish.

Specific gravity....................................1000.521

100,000 grains contain:

Suspended matters....................................37.680

The suspended matters, as in the preceeding case consisted chiefly of animalcules, vegetable cells, decaying, organic and vegetable matters, phosphates of lime, magnesia, and silicates of soda and potassa, silica, oxide of iron and other organic and inorganic matters.

It was found to be very difficult to separate the insoluble suspended matters. Even when allowed to stand for days, a large portion showed no disposition to settle, and even after careful filtration a large portion remained suspended.

Solid residue		67.648
Carbonate of Lime, 2.514,	Lime	1.408
	Carbonic Acid	1.106
Carbonate of Magnesia, 1.293,	Magnesia	0.616
	Carbonic Acid	0.677
Phosphate of Lime, Phosphate of Magnesia, Phosphate of Soda, Phosphate of Potassa, Soda and Potassa which had been combined with Organic Acids.		16.885
Chlorides of Sodium and Potassium, 1.806,	Sodium and Pots'm.	0.745
	Chlorine	1.061
Sulphates of Soda and Potassa, 1.868,	Soda and Potassa	0.911
	Sulphuric Acid	0.957
Silicates of Alumina, Soda, Potassa, Magnesia and Lime, casts of Animalcules, Silicious matter of vegetable cells, Insoluble suspended matters which could not be removed by filtration,		22.551

Organic matters, Ammonia, Putrifying vegetable, Albumen and Fibrin, Urea, Uric Acid, Crenic and Apocrenic and Humic Acids, Animalcules of many species, Microscopical plants of many species, Sporules of vegetables.	....9.659
Carbonic Acid Gas, Oxygen Gas, Atmospheric Air, Sulphuretted Hydrogen, Phosphuretted Hydrogen, Carburetted Hydrogen, other undefined gases and volatile matters.	

ANALYSIS 45. Stagnant Swamp Water from the same Swamp as the preceding specimen.

The portion of the canal from which this was taken, upon thė same day, was deeper, and being one mile farther down and nearer the junction of the swamp with North Newport river, had flowed longer, and was not in such a polluted state. The comparative purity of these waters was demonstrated by their greater transparency and freedom from sediment, and by the fact that the fish had not yet commenced to die, and the catfish although existing in large numbers, had not exhibited signs of distress, and did not move about upon the surface of the waters.

Specific gravity....1000.2501

100,000 parts contain:

Suspended matters....	12.860
Solid residue....	30.055

The suspended matters consisted of animalcules, vegetable cells, vegetable and animal matters, silicates and phosphates of lime, magnesia, soda and potassa, and many other organic and inorganic compounds.

Carbonate of Lime, 5.533,	Lime....	3.099
	Carbonic Acid....	2.434
Phosphates of Lime, " " Magnesia, " " Soda, " " Potassa,	....	traces.
Chlorides of Sodium and Potassium, 5.698,	Sodium & Potassium....	2.356
	Chlorine....	3.342

Sulphates of Soda & Potassa, 5.098,	Soda & Potassa	2.153
	Sulphuric Acid	2.945
Insoluble Silicates, Silicic Acid & fragments of the shells of Animalcules and other suspended matters, as Silicate of Alumina which passed through the filter.		10.519
Organic matters, Ammonia, Animalcules, Vegetable Cells, Decaying Animal & Vegetable matters		6.440
Carbonic Acid Gas,		
Atmospheric Air,		
Oxygen,		
Sulphuretted Hydrogen, 3.609,	Sulphur	3 397
	Hydrogen	0.212
Phosphuretted Hydrogen,		
Carburetted Hydrogen,		
and other undetermined Gases.		

These analyses show the great complexity of the constitution of the waters and deposits of swamps, and demonstrate their great value in Agriculture.

Droughts which cause the death of fish, are by no means uncommon, and their bones are added to the deposit upon the bottoms of the swamps.

The value of such deposits will be placed in a clear light by the following calculations:

	PHOSPHATES OF LIME & MAGNESIA. pounds.
100 pounds of the swamp deposit in Analysis 43, will yield,	22.224
One Ton " " " "	444.480
100 bushels " " " "	2222.400
200 " " " " "	4444.800
300 " " " " "	6667.200
400 " " " " "	8889.600
500 " " " " "	11112 000
1000 " " " " "	22224.000

	PHOSPHORIC ACID. pounds.
100 pounds of the swamp deposit in Analysis 43,	13.958
One Ton " " "	279.160
100 bushels " " "	1395.580
200 " " " "	2791.160
300 " " " "	4186.740
400 " " " "	5582.320
500 " " " "	9977.900
1000 " " " "	13955.800

The deposits of swamps and forests are the great sources of fertility which will supply the Planters of the South with those organic and inorganic elements which are needed to replace the compounds annually sent off the plantations.

(*b.*) *Waters of the Swamps into which the Salt water occasionally flows.*

ANALYSIS 46. SWAMP WATER FROM THE CHANNEL OF LAMBERT'S SWAMP, LIBERTY CO., 2 MILES FROM ITS JUNCTION WITH NORTH NEWPORT RIVER, MAY 28TH, 1860.

Swamp almost entirely dry, with the exception of the deep channel from which this specimen was taken. The waters presented a blue color in mass, in the swamp. After standing several days in glass vessels there was a deposit of dark almost black mud, and the transparent water presented a straw color. The bottom of this swamp is covered with a similar black deposit, consisting of vegetable and animal remains, with varying proportions of sand, alumina, and insoluble silicates, together with the organic acids and mineral salts resulting from the decomposition of vegetable and animal substances ; the silicious remains of animalcules form a considerable portion of this deposit—these matters rest upon stiff blue clay. In dry seasons, during spring tides, and especially during the equinoctial storms, this swamp is subject to slight overflows of the waters of the North Newport river ; which, as we shall subsequently show, are during the dry seasons impregnated with the salts of sea water. During wet seasons, the rivers which receive the waters of the swamps, are fresh nearly to the commencement of the inner chain of islands ; whilst during dry seasons the line of salt water advances far inland.

It is evident from these facts that the conjunction of an equinoctial storm with an excessively dry season, might be attended by the ingress of the salt water far inland, and thus cause the death of the trees of large tracts of swampy land.

We have had several instances of this upon the coast of Georgia.

Specific gravity, ... 1002.546

100,000 grains contain :

Suspended matters....................................4.320

The suspended matters consisted of phosphates of lime and magnesia, organic acids, silicate of alumina, soda and potassa, animalcules of several distinct species, microscopical plants, and vegetable and animal matters in various stages of decay. The first had not yet commenced to die and the waters were in a far purer state than those whose composition were given in analyses 43, 44 and 45.

Solid residue		86.000
Chloride of calcium 16.906	Calcium	5.693
	Chlorine	10.213
Chloride of magnesium 6.039	Magnesium	2.178
	Chlorine	3 861
Sulphate of lime		trace
Phosphate of lime		trace
Sulphate of magnesia 9.777	Magnesia	3.259
	Sulphuric acid	6.518
Chloride of potassium, Bromide of sodium, Bromide of potassium, Iodide of sodium, Iodide of potassium, Sulphates of soda and potassa, Soda and potassa separated from the organic acids,		3.191
Chloride of sodium 42.420	Sodium	16 689
	Chlorine	25.731
Organic matters Animalcules, Microscopic vegetables, Germs of plants and animals, Humic, crenic and apocrenic acids, Ammonia, Undefined products of decaying animal and vegetable matters,		6.667
Silicic acid		
Atmospheric air		
Carbonic acid		
Oxygen		
Sulphuretted hydrogen		
Phosphuretted hydrogen		
Carburetted hydrogen		

c. *Waters of the Rivers which drain these Swamps, and do not extend beyond the first plain.*

The character of the waters of these short salt rivers varies with the season, and with their distance from the sea : in wet seasons the waters are fresh nearly to the mouths of these rivers, whilst in very dry seasons

they become salt up to their junction with the swamps. During the dry seasons these waters, even near their sources, cannot be used in the cultivation of rice; and even when they are carefully excluded from the rice fields which lie in the river bottoms, the salt watèr percolates through the dams and kills the rice for several yards back.

ANALYSIS 47.—WATERS OF THE NORTH NEWPORT RIVER, AT MONTEVIDEO, THE PLANTATION OF REV. C. C. JONES, D. D., 2 MILES FROM RICEBORO, AND 4 MILES FROM THE JUNCTION OF LAMBERTS SWAMP, the analysis of whose waters have just been presented, May 31st, 1860. At this point the river is 30 yards wide, and 18 feet deep at high water; it diminishes rapidly towards its head waters, and in the course of a few miles divides itself into small creeks, which receive the waters of the various tributary swamps. Specimen selected near low water, tide still running down.

The lands along this small river, above the salt marshes, are equal to any in this section of the State, consisting of a black surface deposit of from 1 foot to 4 feet of vegetable matters, stumps, trunks, leaves, &c., of trees in various stages of decay—mixed with dark blue and black clay and fine sand; and beneath this, stiff blue clay, containing the stumps o former forests. Great difficulty is experienced in digging the deep ditches and canals, from the presence of the stumps of ancient forest trees, oak, cypress, and other trees, many feet beneath the present surface.

Specific gravity............................1002.86

100,000 grains contain:

Suspended matters....................................3.900

The suspended matters vary greatly with the season of the year—they are most abundant in wet weather. They are composed of animal cules, vegetable and animal matters in process of decay, fine sand, and silicate of alumina.

Solid residue			447.500
Chloride of calcium	25.309	Calcium	9.127
		Chlorine	16.182
Sulphate of lime	0 643	Lime	0.265
		Sulphuric acid	0.378
Phosphate of lime			traces
Nitrate of lime			
Chloride of magnesium	60.197	Magnesium	15 221
		Chlorine	44.976
Sulphate of magnesia	48.181	Magnesia	16.060
		Sulphuric acid	32.121
Sulphate of soda			
Sulphate of potassa			
Nitrates of soda and potassa			

Chloride of sodium 266.855	Sodium	104.988
	Chlorine	161.867
Chloride of potassium		
Phosphates of soda and potassa		
Bromides of sodium and potassium		
Iodides of sodium and potassium		
Silicic acid		
Silicates		
Alumina		
Oxide of iron		
Ammonia		
Decaying animal and vegetable products		
Animalcules		
Microscopical plants		
Carbonic acid		
Sulphuretted hydrogen		
Carburetted hydrogen		
Atmospheric air		

This analysis shows the large proportion of the chlorides and sulphates of lime, magnesia and soda which exist in these waters during dry seasons, rendering them unfit for the culture of rice and for irrigation generally.

This change in the physical constitution of the waters of these short rivers depend upon physical causes, over which the planter can never have control, and hence in very dry seasons the rice crop must necessarily suffer more on these small salt rivers than upon the Altamaha, Ogeechee, and Savannah rivers, which drain a larger tract of country.

d. *Waters of the Rivers which derive their waters from the primitive regions as well as from the great Tertiary Plains and Swamps of Georgia.*

The waters for this examination should be selected as near the sea as possible, and at the same time above the line of brackish water.

ANALYSIS 48.—WATERS OF THE OGEECHEE RIVER, BRYAN COUNTY, plantation of Miss Eliza Clay, 1 mile from the crossing of the Savannah, Albany and Gulf Railroad—half high water, tide running down—season hot and dry. May 26th, 1860.

In mass the waters of the Ogeechee River present a beautiful deep blue color, like sea-water, thus presenting a striking contrast to the turbid yellow and red waters of the Savannah and Altamaha on either side.

The sediment of the Ogeechee River is of a lighter color and much less in quantity than that of the Savannah and Altamaha; and appears to be composed in great measure of the light colored joint clay of the eocene formation. The sediment of the Ogeechee river contained a greater number and a greater variety of animacules than the sediment

of the Savannah river, examined at the same time. Whether this is always the case, cannot be decided without a series of observations, extending over several years. As far as I have compared the animalcules of these two rivers, they appear to differ within certain limits. We hope upon some future occasion to present to the Cotton Planters' Convention a report upon the character and offices of the animalcules of Georgia, illustrated by numerous drawings of the characteristic species.

Sp. gr. at 60.o.................... ....1000.1314

100,000 grains contain :

Suspended matters.....................................3.300

The suspended matters (sediment) were almost entirely free from particles of mica or sand, and were, in fact, a mixture of yellow clay, animalcules and microscopic plants, containing traces of ammonia, phosphate of lime, phosphate of soda, phosphate of potassa, phosphate of magnesia, sulphates of lime, soda, potassa and magnesia, and chlorides of soda and potassa.

Solid residue		9.040
Carbonate of Lime, 4.210,	Lime	2.338
	Carbonic Acid,	1.872
Carbonate of magnesia 1,072	Magnesia	0.463
	Carbonic acid	0.509
Sulphate of Lime,		trace
Phosphate of lime		trace
Sulphate of magnesia		trace
Chloride of sodium 1.492	Sodium	0.544
	Chlorine	0.848
Chloride of potassium		trace
Sulphates of soda and potassa 0.433	Soda and potassa	0,213
	Sulphuric acid	0.220
Ammonia		trace
Peroxide of iron		trace
Silica		trace
Alumina		trace
Animacules, Vegetable cells, Decaying vegetable matters, Crenic and apocrenic acids,		1.810

If we institute a comparison of the waters of the Ogeechee at this point, with the analysis of the waters in Burke and Emanuel counties, we will see that the proportion of carbonate of lime has remained the same, whilst the magnesia and chlorides and organic matters have increased. The increase of the organic matters is readily accounted for by the addition of the waters of extensive swamps loaded with decaying vegetable matters. The increase of the magnesian salts and of the chlorides is most probably due to the proximity to the sea.

ANALYSIS 49.—WATERS OF THE SAVANNAH RIVER, opposite the City of Savannah, May 23d, 1860. Specimen selected from the middle of the river, tide running down, having fallen about 3 feet. The season had been very dry both in the north and south of Georgia and South Carolina, the tributary swamps and creeks were low, and the river itself was unusually low.

In mass, the waters of the Savannah river present throughout their course a turbid reddish brown color—in small quantities, as in a bottle, they present a semi-translucent and reddish yellow color. This color is due to suspended matters which settle slowly upon standing. The character and amount of the sedimentary matters varies according to the amounts, positions and characters of the waters which the river receives in its course through different geological formations. In wet seasons, in the upper primitive regions of Georgia and South Carolina, when the waters rush down from the barren red-clay hills, the red deposit is increased. In rainy seasons in the low country of Georgia and South Carolina, the dark blue and black deposits of the swamps and low lands are increased. In rainy seasons, throughout the States of Georgia and South Carolina, both at the source and along the course of the Savannah, the red and bluish and black deposits are equally increased. The amounts of both characters of deposit will be increased in wet and diminished in dry weather.

These deposits differ in chemical constitution and in the characters of the animalcules—the red deposit contains more iron silicate of alumina, and sand and mica, and less organic matter and lime than the darker deposits of the swamps.

In the present sample, the sedimentary matters amounted to only 6.3 grains to the gallon of water. Under the microscope this deposit was found to consist of numerous animalcules of various sizes and species (several of the species appeared to be identical with those described by Ehrenberg and other European naturalists, whilst others appeared to be identical with those found by Dr. Bailey in the deposits of the rivers of New York—these facts will receive fuller attention hereafter), microscopial plants, fine particles of sand, too minute to be distinguished by the naked eye, and requiring a high magnifying power for their detection, small fragments of colored crystals, and of mica from the primitive regions of Georgia and South Carolina, small fragments of wood, and silicate of alumina colored red by oxide of iron.

These facts are of great interest to the agriculturist, for they show him the highly complex nature of the deposit from the Savannah river, which contains the following substances :

Silicate of Alumina.
Silicate of Potassa.
Silicate of Soda.
Silicate of Lime.
Silicic acid.
Oxide of Iron.
Carbonate of Iron.
Carbonate of Lime.
Phosphate of Lime.
Sulphate of Lime.
Carbonate of Magnesia.
Phosphate of Magnesia.
Sulphate of Magnesia.
Sulphate of Potassa.
Phosphate of Potassa.
Chloride of Potassium.
Sulphate of Soda.
Phosphate of Soda.
Chloride of Sodium.
Ammonia.
Animalcules, highly complex in structure, containing many different organic and inorganic compounds, and capable of yielding ammonia during decomposition.
Vegetable organisms, and decaying vegetable matters, also highly complex.

The deposit from the Savannah river does, then, contain all the elements necessary to sustain the most luxuriant vegetation. The establishment of this fact leads to the development of a valuable principle in the agriculture of rice plantations.

The rice planters should ever remember that their manure lies in the waters of the rivers—that the rivers contain inexhaustible stores of fertility, which if continuously and properly employed, will maintain their lands in undiminished fertility for unnumbered ages. When the rice lands are not covered with the growing crops, they should be covered with the waters of the rivers, which should be drawn off and renewed as often as the sediment settles on the land. By successive inundations in this manner, the land may be covered with a rich deposit, which may be renewed whenever necessary, with no other expense than the letting of the waters on and off. This mode of enriching rice lands is at once the most thorough, the most lasting, and the cheapest.

Specific gravity	1000.07
100,000 grains contain:	
Suspended matters	9.000
Solid residue	7.000

Carbonate of lime 1.680	Lime	0,941
	Carbonic acid	0.739
Carbonate of magnesia 0.436	Magnesia	0.154
	Carbonic acid	0.282
Sulphate of lime		trace
Phosphoric acid		trace
Sulphate of magnesia		trace
Chlorides of calcium and magnesium		traces
Chloride of sodium 0.690	Sodium	0.250
	Chlorine	0.440
Sulphates of soda and potassa 1.073	Soda and potassa	0.568
	Sulphuric acid	0,505
Silicic acid, Alumina, Peroxide of iron, Carbonate of iron		1.400
Ammonia, Decaying vegetable matters, Decaying animal matters, Organic acids, crenic and apocrenic and humic acids, Animalcules, Vegetable cells, microscopical plants,		1.667

If this analysis be compared with that previously recorded of the Savannah River, opposite Augusta (Analysis 32), it is evident that the carbonate of lime exists in double the quantity in the waters of the river opposite Savannah. This difference in the proportion of lime is readily explained by the fact that the Savannah river passes through the eocene shell limestone formation, as is well known to every one who has ever passed down this river from Augusta to Savannah. Shell Bluff, on the Savannah River, which marks the northern limit of this formation, has been described by various travellers even before the revolutionary war. The Savannah also receives the waters of Brier creek, which flows through this formation in Burke and Screven counties. The main body of the waters of Brier creek are, however, derived from the primitive regions and non-fossiliferous tertiary strata of Richmond county; and the streams which flow from this formation in South Carolina and empty into the Savannah, are so small and inconsiderable as to be without geographical names. Whilst, therefore, the shell limestone formation has added one-half more carbonate of lime to the waters of the Savannah, they are still remarkably free from this element, and will compare favorably for drinking purposes with any river water in the world.

The salts of magnesia, soda, and potassa, and the organic matters, exist in greater proportion in the waters of the river opposite Savannah than in the waters opposite Augusta, from the obvious reason that the

waters of the river have received the concentrated waters of the numerous swamps in the tertiary plains which it drains, and also to their proximity to the Atlantic ocean; for even when the waters are not actually transported by the tides, the salts may, by diffusion, travel some distance above the line of actual flow of the waters of the sea.

ANALYSIS 50.—Water from a Canal in the interior of Hutchinsons Island, directly opposite the Savannah Exchange, the waters were clearer and appeared to contain less suspended matters than those of the Savannah: after the settling of the deposit the waters presented a light straw color: tide running down: the specimen represented then the water as it was leaving the island, after it had been subjected to the action of the vegetation, surface and hot sun: the day was clear and the rays of the sun very hot: 2 o'clock P. M., May 23d, 1860.
Sp. Gr. at 60° .... 1000.1203.

100,000 parts contain:
Suspended matters.................................. 3.000

Like the deposit from the river examined at the same time, this contained animalcules, microscopical plants, silicate of alumina colored by oxide of iron, minute particles of silica, mica and other primative minerals together with traces of various salts of organic compounds, as carbonates of lime, magnesia and iron, chlorides of calcium, magnesium sodium and potassium, phosphates of lime, magnesia, soda, potassa, ammonia and organic acids, and various undefined vegetable and animal compounds. When compared with the waters of the river we find that it is similar in constitution, but much less in amount, $\frac{2}{3}$ds. of the suspended matter having been deposited during the flow of the waters over the island, which is fast relapsing into its original condition, and is now over a large portion of its surface covered with reeds and flags which act as filters to the waters and separate the suspended matters.

This examination illustrates the readiness with which the suspended matters of the waters of rivers may be deposited when the water is spread over the surface of the land in thin sheets.

Solid Residue		8,500
Carbonate of Lime, 2,214,	Lime	1,240
	Carbonic Acid	0,974
Sulphate of Lime		trace
Phosphate of Lime		trace
Chloride of Calcium		trace
Carbonate of Magnesia, 1,017,	Magnesia	0,359
	Carbonic Acid	0,658
Sulphate of Magnesia		trace
Chloride of Magnesia		trace

Chloride of Sodium, 0,312,	Sodium...........	0,123
	Chlorine..........	0,189
Sulphate of Soda and Potassa, 0,746.	Soda and Potassa...	0,368
	Sulphuric Acid.....	0,378
Silicates, Silicic Acid, Per Oxide of Iron, Alumina,	....	1,000
Organic Matters, Animal and Vegetable, Animalcules, Vegetable cells, Microscopic plants, Vegetable Acids, Crenic and Apocrenic and Humic Acid Ammonia,	......	3,000

The slight changes in the composition of this water are due without doubt to many causes, the chief of which are, concentration by the rays of the sun, chemical and physical actions of the numerous plants amongst which it flowed, and to chemical changes induced by the decaying vegetable matters and stiff blue clay which composes the surface of this island· Much of the vegetable deposit of previous ages was worked off during the early settlement of the country, and in many portions of the island the stiff blue clay is covered only by a thin film of deposit and vegetable mould, in other parts the decaying reeds and flags with their extensive roots have formed a coating upon this blue clay of more than two feet. These actions are highly complex, and it would be rash to attempt to attribute to each its just share of influence upon the composition of the water.

ANALYSIS 51. WATER FROM A SHALLOW LAGOON IN THE INTERIOR OF HUTCHINSONS ISLAND, covered with small trees, flags and reeds, forming a dense foliage, impenetrable to the rays of the sun: water about 6 inches in depth; the tide flows slowly and with difficulty in and out of this lagoon, and more or less water remains statgnant: the bottom is covered with leaves and decaying vegetable products: May 23d 1860.

After standing, a brownish red deposit fell, and the waters presented a deeper tinge than the waters of the river and canal, thus indicating to the eye the greater proportion of organic matters,

The suspended matters consisted of numerous animalcules, (many of which were living,) simple microscopic plants, particles of decaying vegetables, silicates colored red by vegetable matters, and the oxide of iron, and traces of various salts, as phosphates of lime, magnesia, soda potassa, chlorides and sulphates of the alkalies and alkaline earths·

Sp. Gr. at 60°. f. 1000·14.

100,000 Grains contain:

Solid Residue,.. 10,951

Carbonate of Lime, 3,689,	Lime	2,066
	Carbonic Acid	1,623
Sulphate of Lime		trace
Phosphate of Lime		trace
Chloride of Calcium,		trace
Carbonate of Magnesia, 1,650,	Magnesia	0,583
	Carbonic Acid,	1,067
Phosphate of Magnesia		trace
Sulphate of Magnesia		trace
Chloride of Magnesia		trace
Chloride of Potassium		trace
Chloride of Sodium, 0,436,	Sodium	0,171
	Chlorine	0,265
Sulphate of Soda and Potassa, 0.410,	Soda and Potassa	0,190
	Sulphuric Acid	0,220
Silicates, Silicic Acid, Peroxide of Iron.		1,656
Organic Acids, Crenic and Apocrenic, &c., Ammonia, Animalcules, Microscopical plants, Animal and Vegetable matters in process of decay,		3,000

(*e*.) *Waters of the Wells and Springs of the First Tertiary Plain.*

The character of the waters of the springs and wells of the low lands bordering the sea-coast of Georgia will depend upon the depth, the character of the soil, and their distance from the rivers and swamps.

The springs and the wells of water in sandy formations are of great purity, and their composition is correctly represented in analysis 41 of Walthourville branch waters.

In many of these springs and wells which are formed by the waters percolating through sand-beds, which serve the purpose of natural filters, the saline matters are often not more than from one to three grains in the gallon.

The waters of low swampy lands, and ricefields on the other hand are impregnated with organic matters, which in certain seasons, and under certain conditions exert most deleterious effects upon the health of the inhabitants.

The great mortality upon rich places, many of which actually decrease instead of increasing, is due to the character of the waters, which induce bowell affections, and derangement of the blood, and low grades of fever.

The relations of Malarial fever to the organic matters of the drinking waters, demand a most searching and extensive investigation, and without hazarding an opinion at this stage of the investigation we would simply state that we have been engaged in an examination of this complicated question as well as of the character and causes of these diseases of Rice plantations. and hope to present a special report to the Cotton

Planter's Convention at some future day. As the investigation involves much exposure and severe labor it is impossible for me to say when they will develope such results as will be worthy of the consideration of the Cotton Planter's Convention.

Upon the present occasion I will point out a few practical rules which I know by experience, will greatly ameliorate the condition of the inhabitants of Rice plantations.

1*st. Substitute Cistern Water for Well and Spring Water.*

If this report should accomplish no other result, than the introduction of cisterns upon Rice plantations, and in the tertiary lime formation of Georgia, I shall feel myself to be rewarded for my labors. The surface exposed by the Cotton gins, sheds, and barns and dwelling-houses, upon plantations will prove amply sufficient for the collection of an abundant supply of water.

2d. If the cistern water should at any time fail, or if it be impossible to obtain the cistern water, then collect the well and spring water into large barrels or tanks, and add to the mass of water a solution of common alum. One pound of alum pulverised and dissolved in four gallons of water, will be sufficient to purify the drinking water of a large plantation for six months. Of this solution a wine-glass full may be added to every 50 gallons of water.. The alum coagulates the organic matters, they settle, and leave a clear sparkling wholesome water. The minute proportion of alum in the water will exert no injurious effects whatever, it will be only tonic in its action.

3d. Never commence work in the Rice fields and low grounds before sun-rise.

4th. Never allow the laborers to commence work upon empty stomachs. Establish a law as unalterable as those of the Medes and Persians that no one shall leave the quarters without having first cooked and eaten breakfast. Laboring in the morning in the atmosphere loaded with the noxious vapors of the swamps is the most fruitful of all sources of disease.

5th. Avoid as far as possible the dews of the mornings and nights.

6th. Avoid wet clothes as far as possible.

7th. Clothe the feeble, during the fall and winter in red flannel, worn next to the skin.

8th. Treat diseases of Rice plantations and low grounds upon the stimulant plan. Avoid all depletion as far as possible; and in the climate fevers, administer sulphate of quinia boldly regardless of the symptoms of headache and delirium, for this is the great remedy in the diseases of

swamps and ricefields, even in the pleurisy and pneumonia of the winter season, for they are in this section of the country modified by the slow action of malaria upon the system.

9th. Do not attribute the diseases of children in the summer and fall to worms. At this period of the year when children are most liable to climate fever, it is the habit of many planters to dose them with various drastic and disgusting mixtures to rid them of worms, under the idea that the worms are the causes of the fevers of this season of the year, because when the children are taken sick the worms travel away from them through every avenue and in every direction. The explanation of this striking phěnomenon, which upon a superficial view is liable to be taken for the disease, is simply this, during the attack of climate fever, the secretions of the liver, and of the whole intestinal canal are so altered, that the worms which have been quietly housed all winter. in comfortable quarters, without exciting any injurious effects upon the unconscious landlords are suddenly sickened and disgusted with their altered fare and habitations, and beat a precipitate retreat in the most convenient and natural directions. If you treat the disease for worms alone, the real disease, climate fever, will march steadily on and you may purge the child until the last worm is evacuated, and only hasten the fatal end, because you are working in conjunction with the disease, all the tendencies of which are depressing.

If on the other hand, you administer a gentle purgative mixed with a full dose of sulphate of Quinia, and follow up with gentle stimulants and sulphate of Quinia the termination of almost every case will be favorable and that too in a few days.

We are persuaded that strict attendance to these simple rules will be the means of materially diminishing the diseases and the rate of mortality upon Rice plantations.

Analysis 52. Waters of a celebrated spring in the Western end of Colonels Island, upon the plantation of Rev. C. C. Jones, D. D., called Maybank

We have selected the waters of this spring as a type of the only other class of waters in this section of the State, which it is desirable that we should examine.

This spring has existed unaffected by droughts or rain since the settlement of the country; within sight are eight Indian mounds, containing numbers of skeletons, and the surface of the island is covered with fragments of Indian pottery and oyster shells evidently deposited in great measure by the Indians. These facts render it probable that this spring

was known for ages to the Aborigines, and that its wholesome waters were highly prized.

The waters of this spring issue out of the side of the sandy formation, which composes almost the entire island; about 12 feet beneath the surface, and 2 feet above the point of high tide; and form the head of a small creek which empties into an extended marsh, fifty yards from the spring.

The salt water at high tide flows up to within a few feet of this spring and the high tides during the equinoctial storms sometimes cover the spring and surrounding lands within eight feet of the general surface of the Island. It is interesting and important to determine the character of these waters which are discharged within a few yards of the salt water at high tide. Waters as clear as crystal, tasteless, wholesome.

No Deposit.

Specific Gravity at 60°. f.,............................1000,1305

100,000 Grains contain :

Solid Residue		8,000
Carbonate of Lime, 6,025,	Lime	3,372
	Carbonic Acid,	2,653
Sulphate of Lime		trace
Carbonate of Magnesia, 0,0156,	Magnesia	0,0077
	Carbonic Acid,	0,0079
Sulphate of Magnesia,		trace
Chloride of Sodium, 0,872,	Sodium	0,343
	Chlorine	0,529
Sulphate of Soda and Potassa, 0,279,	Soda and Potassa	0,132
	Sulphuric Acid	0,147
Organic Matters		trace
Silicic Acid		trace

We are at once struck with the absence of chloride of sodium, and of the sea salts generally, from this water. Their absence is explained by the fact that the waters of the spring flow out above the line of high tide, and are also derived from the extensive sandy formation of the island,from which the soluble chlorides have been continually washed out by the waters percolating through this natural filter. The presence of the carbonate of lime is readily explained by the numerous shells which cover the surface of the Island.

Colonels Island, notwithstanding that it is surrounded with extensive salt marshes covering thousands of acres, is one of the healthiest localities in the world.

The health of these sandy sea Islands is always good, except near the mouths of those rivers which discharge large quantities of fresh-water into the ocean.

It is an interesting fact that, the large quantities of sulphuretted hy-

drogen liberated from these salt marshes, and often in such quantities as to be disagreeable even at the distance of several miles, exert no deleterious effects upon the inhabitants who are as a general rnle exempt from climate fevers.

Waters of the Atlantic Ocean.

ANALYSIS 53. Salt water from a short deep river which flows through extensive marshes, and receives but little water from any source except the sea, Colonels Island, May 31st, 1860.

This sample of water was taken, five miles from the Atlantic Ocean, at half tide: running down. The water from this river was selected in preference to that of the Atlantic Ocean, because we wished to test the value of the waters of the short rivers of these extensive marshes, for the manufacture of salt for Agricultural purposes.

This short river is not connected with any swamp, is not more than eight miles in length, and simply drains the extensive marsh lying to the west, and north-west of Colonels Island, and between this island and the Atlantic Ocean.

Specific Gravity at 60°. f.		1019,0013
100,000 Grains Contain:		
Suspended Matters		2 Grains
Suspended matters resembled black mud, and contained nuimerous animalcules.		
Solid Residue		2502.50
Anhydrous Sulphate of Lime, 143,630,	Lime	59,142
	Sulphuric Acid	84,488
Sulphate of Magnesia, 139,103,	Magnesia	43,034
	Sulphuric Acid	96,066
Chloride of Magnesium, 433,161,	Magnesium	158,010
	Chlorine,	275,151
Chloride of Sodium, 1652,432,	Sodium	650,118
	Chlorine,	1002,314
Chloride of Potassium, Bromide of Potassium, Bromide of Sodium, Iodide of Potassium, Iodide of Sodium, Silicic Acid, Silicates, Organic Matters, Phosphates of Lime and Magnesia,		133,174

This analysis demonstrates that the waters of these salt rivers are valuable sources of salt for both Commercial and Agricultural purposes.

In a future report we will discuss the Commercial and Agricultural relations of these salts, and also present drawings and minute descriptions of the best mode of manufacturing salt.

Waters of the Cities and Towns of Georgia.

We shall in the present report, present observations upon the waters of the two largest cities in Georgia.

Waters of Augusta.

We have already presented analyses of the waters of Turknett Spring and Savannah River—the former used by the citizens for 25 years, and the latter to be introduced into the city in the course of a few months. These analyses show that these waters are as pure as the waters furnished to any city in the world. It remains that we should examine the pump waters, which for near one century, were used by the inhabitants for drinking water.

According to the testimony of the oldest inhabitants, the waters in their original state were pure, and became contaminated with the increase in the population of the town, and pump after pump, in the more thickly and older settled portions, was abandoned for those of the outskirts of the town.

The city of Augusta is situated upon a level plain, the soil of which is composed of alternate layers of sand and clay with coarse sand and pebbles for 75 feet, and rests upon the primitive non-fossiliferous rocks. Several attempts, in different portions of the town, to bore artesian wells, have in each instance been arrested by primitive rocks, Gneiss and Chlorite Slate. The superficial layers of the soil contain much mica in the constitution and have been evidently derived from the suspended matters of the river. An examination of the strata upon which Augusta rests, shows that there is no cause of contamination in their chemical constitution. Before these strata were inflitrated by the excrementious and fæcal matters and sewage water of the city, these waters, without doubt, possessed the same remarkable purity as the waters of the Savannah River and Turknett Spring. These, therefore, form correct standards to which they should be compared in their present condition,

Analysis 54. Pump Water from the intersection of Centre and Green streets. September 10th, 1860. Hot and dry weather.

100,000 grains contain:

Solid Residue		78.972
Nitrate of Lime, 22.400	Lime	7.649
	Nitric Acid	14.751
Sulphate of Lime, 0.181	Lime	0.074
	Sulphuric Acid	0.107
Chloride of Calcium, 12.562	Calcium	4.528
	Chlorine	8.034
Nitrate of Magnesia, 7.525	Magnesia	2.034
	Nitric Acid	5.491
Chloride of Magnesia, 10.749	Magnesium	2.715
	Chlorine	8.034

Nitrate of Ammonia, 15.128	Ammonia	5.288
	Nitric Acid	9.840
Nitrates of Soda and Potassa		10,382

The waters of this pump have a decided saline taste and are unfit for washing clothes, and produce most deleterious effects when used for drinking or cooking. I have experienced the evil effects of this miserable compound in my own person, when I first removed to Augusta, two years ago; not being aware of the condition of the pump water, I used it for several days. The first effects were intense, insatiable thirst, followed with derangement of digestion and of the bowels.

ANALYSIS 55. Pump Water, Green street, between Washington and Centre streets. September 10th, 1860. Hot and dry weather.

100,000 grains contain:

Solid Residue		74.033
Nitrate of Lime, 15.952	Lime	5.447
	Nitric Acid	10.505
Sulphate of Lime		trace.
Nitrate of Magnesia, 11.170	Magnesia	3.100
	Nitric Acid	8.070
Chloride of Magnesium, 7.430	Magnesium	1.810
	Chlorine	5.620
Chloride of Sodium, 13.480	Sodium	5.300
	Chlorine	8.180
Nitrate of Ammonia, 6.097	Ammonia	2.009
	Nitric Acid	4.088
Nitrates of Soda and Potassa		18.700

The taste of this water is so strong and disagreeable that not even horses can be induced to drink it, and the pump has been abandoned for several years.

ANALYSIS 56. Pump Water, intersection of Broad and Washington streets. September 10th, 1860.

100,000 grains contain:

Solid Residue		43.642
Nitrate of Lime, 17.280	Lime	5.900
	Nitric Acid	11.380
Chloride of Calcium, 3.995	Calcium	1.476
	Chlorine	2,519
Sulphate of Magnessia, 3.315	Magnesia	1.105
	Sulphuric Acid	2.210
Chloride of Magnesium, 8.273	Magnesium	2.092
	Chlorine	6.181
Chlorides of Sodium & Potassium, 6.197	Sodium & Potassium	2.436
	Chlorine	3.761
Nitrates of Soda and Potassa		1.060
Chloride of Ammonia, 0.399	Ammonia	0.105
	Chlorine	0.294

ANALYSIS 57. Pump Water, Broad street, between Metcalf and Campbell streets, opposite the Planters' Hotel. September 10th, 1860.

100,000 grains contain:

Solid Residue		72.704
Anhydrous Sulphate of Lime, 4.756	Lime	1.958
	Sulphuric Acid	2.798
Nitrate of Lime, 8.566	Lime	2.925
	Nitric Acid	5.641
Chloride of Magnesium, 15.674	Magnesium	4.130
	Chlorine	11.544
Nitrate of Magnesia, 7.664	Magnesia	2.093
	Nitric Acid	5.571
Chloride of Sodium, 12.027	Sodium	4.730
	Chlorine	7.297
Nitrate of Ammonia, 18.030	Ammonia	5.860
	Nitric Acid	12.170
Nitrates of Soda and Potassa		4.673

The waters from this pump have been abandoned alike by man and beast..

The large proportion of nitrates in the waters of the pumps in the old settled portions of Augusta is readily explained, when we consider that there is not, and never has been any proper system of sewerage in Augusta—the drains in many of the streets are open ditches—the privies, which are sunk into the ground, are scarcely, if ever, cleaned out, and those which rest upon the ground, are cleaned not oftener than once a year, the soluble portions of the excrement and the urine being allowed to sink into the earth and saturate the soil and contaminate the water—the excrement and urine of the horses and cows in the streets, in like manner, are allowed to sink into the porous soil. Lime is extensively employed during the summer season for the purification of the streets, drains and privies, which excites decomposition in the organic matters, which results in the formation of nitrates of lime and the alkalies. We have, then, in the city of Augusta the same arrangements employed by the manufacturers of nitre from manure and lime and urine.

Waters of Savannah.

The elevated plain upon which Savannah is situated, is composed almost entirely of sand, in some places discolored with iron, and in others slightly mixed with clay, but in general, pure sea sand with no foreign mixtures. When the city was first settled the wells penetrating twenty or thirty feet into the sand, yielded an abundant supply of pure and wholesome water. The analysis of the waters of Colonels Island will, without doubt, correctly represent the composition of the waters of Sa-

vannah, before they became contaminated by the excrements, urine and filth of the inhabitants—and even at the present day, the waters beyond the limits of the town, in the extension to the south of this plain, are pure and wholesome.

The water in the thickly inhabited and older portions of the city have been contaminated by various salts in a manner similar to those of Augusta, To substantiate this assertion, we will upon the present occasion present the results of the analysis of two specimens of water, which I selected at the most favorable period to determine their characteristic properties. Savannah is now abundantly supplied with most pure and wholesome water from the Savannah River, and these pumps, in the older portions of the city are, we believe, almost entirely abandoned,

ANALYSIS 58. Pump water, corner of Whitaker and Liberty streets, Savannah, June 2d. 1860, hot and dry weather.

Sp. Gr. at 60°. f.		1000.5313
100,000 parts contain :		
Solid Residue		67.000
Sulphate of Lime, 1.386,	Lime	0.586
	Sulphuric Acid	0.800
Nitrate of Lime, 15.612.	Lime	5.331
	Nitric Acid	10.281
Nitrate of Magnesia, 6.242,	Magnesia	1.730
	Nitric Acid	4.512
Sulphate of Magnesia, 1.752,	Magnesia	0.584
	Sulphuric Acid	1.168
Chlorlde of Sodium, 23.593,	Sodium	9.291
	Chlorine	14.282
Nitrates of Soda and Potassa		6.301
Sulphate of Ammonia, 11.811,	Ammonia	5.653
	Sulphuric Acid	7.158

ANALYSIS 59. Pump water corner of Bull and Broughton streets, Savannah, June 1st, 1860·

Sp. Gr. at 60°. f.		1000,5714
100,0000 grains contain :		
Solid Residue		55.388
Sulphate of Lime, 1.500,	Lime	0.618
	Sulphuric Acid	0.882
Nitrate of Lime, 15.934,	Lime	5.441
	Nitric Acid	10.493
Sulphate of Magnesia, 0.243,	Magnesia	0.162
	Sulphuric Acid,	0.081
Nitrate of Magnesia, 8.783,	Magnesia	2.434
	Nitric Acid	6.349
Sulphate of Ammonia, 8.543,	Ammonia	3.367
	Sulphuric Acid	5.176
Chloride of Sodium, 15.519,	Sodium	6.106
	Chlorine	9.413
Nitrates of Soda and Potassa		5.720

These analyses show the great extent to which the waters of the wells of Savannah and Augusta have been contaminated by the salts resulting from the decomposition of the excrements and urine of man and animals, blood meat and filth of every description, accelerated and modi-

fied by the action of the large quantities of lime used to purify the streets and privies, and necessarily incorporated with the soil during the erection of houses.

The larger proportion of magnesia in the well waters of Augusta, is readily explained by the difference of the soil of the plains upon which the cities are situated, the earth of Augusta contains materials derived from the primitive regions above, which are rich in the silicates of magnesia, and capable of being decomposed to a certain extent by the quick lime used in the purification of the city, whilst the earth of Savannah, is almost entirely free from magnesia and its compounds, being composed almost entirely of silicious sand.

The results of these examinations demonstrated, that the water of the older settled portions of Augusta and Savannah, are utterly unfit for any of the purposes of life; in fact, if actual disease does not result directly from the use of these waters, they will induce such a state of the system as will aggravate every constitutional tendency, and cause it to fall an easy prey to the mildest epidemics.

In fact these waters are almost as bad as the drainings of graveyards. The water of a well close to the Churchyard on the top of Highgate Hill, recently examined by an English Chemist, Mr. Noad, was found to contain as much as 100 grains of solid matter to the gallon, consisting of—

Nitrate of Lime	40,12
Nitrate of Magnesia	17,06
Sulphate of Potash	17 04
Sulphate of Soda	9,52
Chloride of Sodium	9,63
Chloride of Calcium	5,91
Silica	0,90
	100,18

It will be seen upon comparison of this water from the graveyard with those of Augusta and Savannah, that the differences are those of quantity and not of quality, the constituents are the same in both.

This subject is one of great importance and demands a thorough investigation, for although our towns and cities are at present inconsiderable in comparison with the great cities of the world, or even in comparison with the whole mass of population of Georgia still with the present increase of population, these questions must necessarily assume the magnitude and importance that they occupy in England France and Germany. We have every reason to believe that the origin and prevalence of that terrible scourge to Southern cities, yellow fever, is connected to a great extent with the condition of the soil and waters of our

cities, for it is reasonable to suppose that poisons would not only find a suitable lodgement, but would also be generated in a soil completely permeated and pervaded and contaminated by decaying vegetable and animal matters, it is still more reasonable to suppose that the noxious gases arising from such soil would induce such effects upon the inhabitants as to aggravate every epidemic or contagious disease, however slight its effects upon healthy constitutions. If these questions do not now receive the attention which they merit, we may rest assured that at some future time pestilence and death will place them in their true light. The following is the testimony of Dr. Hassell of London, who has devoted much time to the examination of the waters of London.

*Impure Water a Source of Disease.**

We now approach the consideration of a very important division of our subject, viz: the evidences which exist in proof of the statement that impure water is a source of disease. That the air of the country is more healthful than that of towns and cities is admitted by all, and that vitiated or impure air is capable of affecting the health injuriously, and of giving origin to disease, is universally allowed.

Now we have shown, that whatever the air contains in the shape of impurity, the water imbibes in certain proportions, and from this simple fact it must be admitted that water may and does frequently prove a source of disease, for that which is true of air out of water, can scarcely be less true of air imbibed by water. Now the effects of vitiated air are usually slow and insidious, but not on that account the less important or the less to be guarded against, and analogy leads us to believe that the bad effects produced by impure water, excepting those which occur during the prevalence of epidemics, are of the same slow and insidious character.

D sease occasioned by the earthy and alkaline impurities contained in water.

The whole of the waters in this metropolis and its vicinity are of the kind termed *hard*. Now as has been repeatedly stated, the hardness of water is dependent principally upon the earthy bicarbonates contained in it, but not entirely, as free carbonic acid, and the sulphates also, to some extent, when present, contribute to this hardness. But hard waters usually contain other salts, as the chlorides and alkaline carbonates: these last possess the property of imparting softness to water, so that the degrees of hardness, and the amount of those salts which impart that quality, by no means as a general rule, indicate the whole quantity of the saline constituents of water.

Thus the degree of hardness of *Thames* and other *river waters* supplied to the metropolis varies from 11 to 18 deg, but the gross amount of saline matter to the gallon range from 20 to 28 grains. In *well waters* the quantity of earthy and alkaline salts present is subject to the greatest possible variation. The waters of *artesian wells* are only from 4 to 6 deg hardness, but they contain in addition to the earthy, alkaline salts frequently to the extent of 40 grains to the gallon. Lastly the hardness of some well waters in use, mounts so high as to 50 and even 60 deg., also with variable proportions of the alkaline salt.

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* Food and its adulterations by Arthur H. Hassell, M. D., p. 73, London, Longman, Brown, Green & Longman.

Now, allowing *two quarts* of Thames or other river water to be the average daily quantity consumed in some form or other by each person, there is introdnced into the system every day ten, twelve, or more grains of earthy and alkaline salt. In the same quantity of the waters of artesian wells there is contained from 15 to 20 grains of alkaline salt, with the addition uf a very small quantity of earthy salts. While in a half gallon of the waters of some wells as much as half a drachm of saline water is present.

When it is remembered therefore, that about five grains of the earthy or alkaline carbonates constitutes a medical dose, the conclusion is indisputable that the amount of those salts contained in the waters now in use, is sufficient to produce medical action, and therefore in some cases to affect the health. So convinced of this fact are many physicians, that it is their practice in derangements of the digestive and renal organs frequently to prescribe distilled water. This practice was extensively adopted by the late Dr. Prout. In health the urine exhibits an acid reaction, but a very large proportion of those who are out of health and suffering from debility, pass feebly acid, and more generally alkaline urine.

Now, there can be no question but that the daily use of alkaline waters, which those now supplied to London really are, as is shown by their action on reddened litmus paper, tends to perpetuate this condition of the urine, and to prolong this stage of debility.

This view of the action of the waters at present iu use, we are satisfied, is a very important one. Another serious and well established result of the use of hard water, is the liability incurred to the formation of calculus, especially calculi of lime For proof that the above statement of the effects of the daily use of hard and alkaline waters on health are not over estimated, we will now proceed to quote medical evidence.

In Dr. Sutherlands report on water contained in appendix III. of the report of the General Board of Health on the supply of water to the metropolis. Dr. Leech gives the following evidence: "It has been observed that since this change urinary diseases have become less frequent, especially those attended with the deposition of gravel. So far as experience has gone, my own opinion is that dyspeptic complaints have become diminished in number. With the same reservation as to time it is the opinion of the medical profession, that fever has numerically diminished, and that the cases which occur are more amenable to treatment, by the use of the soft water supply than they were with the former supply.

" During the late cholera there was a remarkable circumstance which deserves notice as compared with the epidemic of 1832. Since the former period the population of Glasgow, south of the Clyde has nearly doubled; and with this exception, and the introduction of the soft water supply, the circumstances might be considered the same at both periods. In one district, the parish of Gorbals, the attack in 1832 was fearful; while Glasgow north of the Clyde, also sufferred severely. During the late epidemic, Gorbals parish furnished comparatively a small number of cases, while the epidemic in other parts of Glasgow was very severe. The unanimous opinion of the Medical Society was that this immunity was to be attributed to the soft water supply."

In the same report Dr. Paton of Paisley gives nearly similar evidence, "I was not in town previous to the filtered river water being used, but in the first ten years of my practice here from 1827 to 1838, cases of calculous disorders were very numerous; the last ten years I have seen few or none, unless old cases previously affected, or in parts not accessible to the water of the company, and a few from some of the chalk counties of England. With regard to the time previous to the introduction of the filtered river water, which must have been about 1804 or 1805, I can communicate nothing of my own knowledge; but from frequent conversations with my partner, the late Dr. White, I was given to understand that the

cases of stone were very numerous. The same thing was often mentioned by other old practitioners. They also mentioned the rapid diminution of them after the river water came to be used in part, and now there is not a single case of calculous disease, except those previously mentioned." But there is also some evidence to show that the diffusion of fever and cholera are also favored by the use of hard water. On this point Dr. Paton makes the following important observations: "Cholera appears, during this last and former attack, to have been more severe in these places where the water is obtained from calcareous wells, or where it is impregnated with other mineral matters, than in those places where it issues from wells over traps, or where it flows over a rocky soil of that nature. I may mention that in Charleston a district of Paisley standing higher and possessing purer air than most of the town, and containing about 4500 inhabitants mostly supplied with water from wells and not from the company, cholera made its most severe attack, hardly missing a family excepting a few who were supplied with pure water. When cholera prevailed I attended many cases of diarrhœa, especially in parts of the town supplied with wells."

And again Dr. Paton remarks, in commenting upon the report of the Local Board of Health of Paisley.

"You will perceive that where pure water has been supplied there have been only 347 cases of fever during twelve months, and where it has not, the numbers have been 502. This difference is not so marked, but when it is is considered that the larger number comes from one-tenth of the inhabitants, and the smaller from the remainder, it is then fully seen what is the value of the pure water.

Disease Occasioned by tha Metallic Impurities contained in Water.

Numerous are the cases which have been recorded of the serious and even fatal results following the use of water containing *lead* in solution.

Since it has been shown that many hard waters act energetically on lead, the presumption has become extremely probable that many obscure effects and attacks, especially of colic, are really to be referred to the lead introduced into the system through the water.

It is to be remembered that lead is one of those substances which accumulate in the system, so that although a very minute quantity only finds its way iuto the body each day, yet after the lapse of weeks or months, the accumulatiou may be so considerable as to produce disease.

The amount of iron present in the London waters is but very small, and scarcely sufficient in itself to produce disease..

The effect of even very minute doses of this metal on some nervous and susceptible constitutions is extraordinary.

Diseases occasioned by the Organic Impurities of Water.

In proof that water highly charged with decomposing organic matter frequently gives rise to severe and fatal diseases, often of an epidemical character we shall be able to produce an abundance of evidence.

To occasion these effects it is probably necessary that the organic matters should resolve themselves into certain deleterious substances and gases, as the carburetted, sulphuretted and phosphuretted hydrogen gases, *cyanides*, &c., as well as doubtless may other lethal products, the nature and composition of which have hitherto eluded the detective powers of chemical seience.

With respect to the effects produced by the living productions contained in impure water, we will quote the evidence given by ourselves before the General Board of Health.

Question 130. What are the observed effects of the consumption of the various forms of animal and vegetable life present in water on health? The fact of the existence in large quantities of living productions belonging to

several distinct divisions of the organic world, and for the most part entirely invisible to the common eye in the waters in general use, was not I believe, generally known until announced by myself in the pages of the Lancet some time since. It is therefore scarcely to be expected that there should as yet have been made many observations tending to show the effects of their consumption upon health, nevertheless, we are not altogether without data upon which to found an opinion, thus the organization and mode of life of many of these productions, as the *entomostraceæ* most of the *infusoriæ* and *algæ*, are such as clearly to unfit them for any prolonged existence in the human stomach and intestines, and there is no qaestion but that when introduced therein they speedily die; the digestible portions being assimilated; but whether this is the case with the *fungi*, the *annelidæ* and certain *infusoriae* and *algæ* admits of doubt.

It is a well ascertained fact that the *fungi* have the power of attacking and proving fatal to many vegetable and the lower forms of animal life. I may here refer to certain experiments I made to test the aggressive and parasitic powers of *fungi*. Many fruits such as apples, pears and peaches and several vegetables, as the lettuce, vegetable-marrow, potato-haulm, &c, were inoculated with the sporules of fungi; the result of this was that they all became speedily diseased, and in a few days many of them entirely disintegrated and destroyed. It is to be observed that these experiments were made on healthy and growing fruits and vegetables; the former were still on the trees, and the latter rooted in the ground. In the softer fruits as the peach and some kinds of apples and pears, the effect of the inoccula tion became visible in less tian twenty-four hours. a dark spot, like that of mortification first appearing and then gradually extending in all directions until the fruit becomes entirely disorganised. There are now also many recorded cases, in which *fungi* have attacked the living animal organism including even man himself; the disease muscardine, which occurs in the silk-worm and many other animals of the same class, as well of the peculiar softening of the tails of fish confined in glass globes, frequently undergo, is attributable to the growth within the tissue of the animal of ramifying filaments of *fungi*. Again *fungi* have been noticed growing on ulcerated surfaces in the human intestines in cases of fevers: they have also been observed in certain affections of the skin and in discharges from the stomach, bladder, bowels and vagina.

With respect to *annelidæ* it is commonly known that several species of worms live in the human intestines, and even grow and multiply there greatly to the detriment of health, and it is difficult to avoid the conclusion that they are really introduced from without, either in the water or through the medium of food.

Aminalcules widely differing from each other have also been found to occur in the human organism in connection with certain diseases. Thus Donne has figured and described a vibrio under the name of the venereal vibrio; the same observer has likewise noticed in vaginal discharges infusoria, which he has named *trichomonades*: and which as well as the vibrio are figured in my book. "On the Microscopic Anatomy of the Human Body in Health and Disease." Other animal productions have been noticed in the humours of the eye, in the muscular tissues, &c.

The only instance of an alga being found in connection with the human subject is that recorded by Dr. Arthur Farre: it was observed in a case attended with vomiting, and has been named *Sarcina ventriculi*. It is particularly worthy of observation that the greater part of the living productions noticed in relation to man have had their seat either on the surface of the body, in the stomach, intestines, urinary passages and uterus: that is almost invariably in positions accessible to the air, an observation leading to the conclusion that they found their way into the frame from without.

"Question 131. The *diatomaceæ*, are I believe, furnished with skeletons of

silex: what becomes of them when introduced into the stomach, and is it probable that they could give rise to results injurious to health? The vitality of the *diatomaceae* is most probably destroyed when introduced into the system: they pass, however, in an entire state and when consumed in any quantity, it is quite possible they might give rise to irritation, in consequence of their unyielding nature and of the elongated and needle-like character of most of the species, the extremities of the frustules frequently being finer and sharper than the points of needles."

In reference to the general effects of the use of water containing decomposing organic matter. Dr. Gavin, in evidence before the Board of Health, states:

"The connection between foul drinking water and cholera was established by irrefragable evidence. The cases where the connection was most clear, were where the parties had been drinking water taken from pumps, near to, and contaminated by the matter of cess pools: but wherever the water was contaminated so as to be nauseous, diarrhœa was invariably present, and affected every person in the habit of drinking such water. I am not aware of any valid exceptions to this law. The most aggravated instance of foul water developing cholera, was where a thirsty navigator drank of the Hackney-brook (a common sewer), and was almost immediately attacked with cholera and subsequently speedily died.

The cases next most marked were those of the eleven persons, out of twenty-two in number, whom I have already recorded as having perished in a certain square, consisting of a few houses where the water was contaminated with cess pool water.

A similar story I have related with reference to the first outbreak of cholera at Fulham. In Hackney, I have shown, how out of sixty-three inhabitants of one locality who drank of water contaminated with cess pool water every one, had had, or then had more or less diarrhœa, and that to avoid its excessive filthness, the whole of the inhabitants of that row were compelled to drink and use for domestic purposes the water that ran down the kennel."

These are the more marked instances, but the cases where foul water led to the development of cholera were so numerous that all the visitors under my superintendence, united in their testimony as to the influence of such water upon the development of cholera. I have traced in many instances the unsuspected cause of the development of the disease in the state of the drinking water. When it is recollected that the water of the poor is almost always exposed to the noxious gases and agencies which arise from privies, and the slow decomposition of the refuse in their yards, and also from those in their close offensive and impure dwellings, it will at once be understood that such water produced much and severe diarrhœa during the period of cholera."

Mr. Bowie, Surgeon, gives the following testimony in reference to the production of cholera from the use of impure water:

"During the raging of the cholera I met with many cases where it was asserted that the badness of the water was the cause of the attack, and I have no doubt that it greatly tended to increase the liability to disease.

"It is well known that cholera raged with frightful and destructive violence in Merthyr Tydfil, Dowlais and other mining towns and villages in South Wales, and in all these places I heard the opinion expressed by many of the population that it was something in the water. The supply was wretchedly defective and the water very impure."

"Again, the water supplied to the Tower was pumped from the Thames at a certain point within 200 yards of a sewer, the contents of which were all the blood and refuse from the butcher shops in Whitechapel.

The soldiers and all the inhabitants of the Tower complained of the water, and attributed a great deal of the disease to its impurity. A regiment that came from Chichester had eighteen on their sick list three days after their arrival. The sickness on that occasion was attributed to the same cause."

The evidence of Mr. Challice, Surgeon, is nearly to the same effect.

"The first fatal case of cholera that I met with was that of a master of a vessel at Gravesend. He was a fine man in the prime of life, and in perfect health when he left London. He was going to the Baltic; he drank rather largely over night, parting with his owners and others, and got up in the morning and drank heartily from one of the water casks which had just been filled with Thames water; he was soon after attacked with purging and vomiting. I went down post and found him dead. I asked particulars and found that his death was so sudden it almost appeared as if he had taken poison in the water. Subsequently it was from facts that came almost hourly under notice, that I formed the opinion of the direct consequences of taking impure water in producing a disordered state of the bowels, and those who had such a state of the bowels were pre-eminently in a condition to become victims to the disease."

Mr. Charles Martin, Surgeon, gives the following evidence, in reference to cholera on Jacobs Island, Bermondsey:

"I think in the greater number of houses there was no water to drink except from the tidal ditches, until about July. At that time a great supply of water was laid on. It had been getting worse for years past: the waters in the ditches becoming in some parts absolutely putrid, thick and slimy.

I know some clusters of houses where they had only such water to drink, and I know that out of five of those houses the inmates of four were affected with cholera. In all the early cases of cholera, the parties were found to have been supplied with water from these ditches. One case was that of a man from Maidstone, who staid at a public house in Mill street for the night. He arrived on Saturday and was attacked with cholera on Monday. In that house no water was laid on, great numbers of the houses in the neigeborhood are still not supplied with water."

Testiminy similar to the above, showing the connection between impure water, cholera, fever and other diseases, might be multiplied to almost any extent, enough however, has been advanced clearly to establish the relation in question."

These investigations upon the waters of Savannah and Augusta, have agricultural as well as sanitary bearings.

The salts contained in these wells are valuable fertilizers, and no waters will produce more powerful effects upon vegetation and yield a greater return for the capital invested than the sewage and drainage waters of cities.

As no attention whatever has been paid to this subject in Georgia, I will adduce the testimony of an eminent agricultural writer, Mr. Henry Coleman, who travelled through Europe for the express purpose of examing and comparing the various systems of agriculture.

Mr. Coleman* thus describes the method of employing in agriculture the drainage water of Edinburgh:

"I come next to speak of a system of irrigation established in Edinburgh, which I looked at with a good deal of interest, where the sewage

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*European Agriculture and Rural Economy from personal observation by Henry Coleman, Honorary Member of the Royal Agricultural Society of England, of the National Agricultural Society of France, and of the National Agricultural Society of the United States. Vol. 11, pp. 159-161.

water from drains of the city are applied to grass lands in its neighborhood, which by this means are rendered most extraordinarially productive.

The drainage water from a large portion of the city of Edinburgh is collected into covered carriers and drains, and from these emptied into a small stream of water, very properly as one may suppose in such case, called the Foul Burn, the term burn being the Scottish name for a small stream or brook. Here it passes along, in an open brook, among some flat lands, which by proper arrangements, it is made to overflow. I I should state that, before it reaches the places where it is thus diffused, it is received in tanks, where the more solid parts are deposited. It does not require any extraordinary acuteness of smell, on approaching these irrigated lands, to become satisfied that the waters, even after passing from the cisterns or tanks, are sufficiently charged with odoriferous particles held in suspension. Indeed, in visiting some parts of the old town in Edinburgh, of Glasgow, and of Dundee, it is difficult to persuade one's self that the inhabitants of those parts are not absolutely defficient in one particular sense.

Whether, with the present habits prevailing in those places, this deficiency is to be considered an evil or a good, I shall not undertake to decide.

This water thus received, is diffused over three hundred acres of land; and these lands are rendered productive to a most extraordinrry degree. One of the principal proprietors, who held his land under a long lease, at a rent of £. 5 per acre, and sub-let this irrigated land at £. 30 per acre, informed me that it was sometimes cut 7 times in one season. The grass is carried into the city, a distance of 2 or 3 miles, for the support of the cows which supply the city with milk. Different channels or gutters are formed for the admission of the water, so that the whole may be flooded. It is applied generally after every cutting, where the situation admits of it; but it is found advisable not to apply it immediately upon the grass being cut, nor before it has obtained some small growth.

The offensive exhalations of meadows thus treated have been the subject of prosecutions at law, as nuisances to health, by parties who derived no benefit from the operation, and whose sense of smell, therefore, was not as I have known in some similar cases, benumbed or bribed by any pecuniary advantage. In the testimony adduced on these occasions, it has been stated that the rent for which some of these meadows are leased in small portions to cow-feeders, varies on an average from £. 20 to £. 30 per acre.

Some of the richest meadows were let in 1835, at £. 38 per acre ; and in that season of scarce forage 1826, £. 57 or $285 per acre, were obtained from the same meadows.

The waste land, called *Figget Whins*, containing thirty acres, and ten acres of poor sandy soil, adjoining them, were formed into water meadows, in 1821 at an expense of £1000. The pasture of the Figget Whins containing thirty acres, used to be let for £40 per year, and that of the ten acres at £60. Now, the same ground, as meadows, lets for £15 or £20 an acre per year, and will probably let for more, as the land becomes more and more enriched ; that is, land which, before the irrigation, let for about $500 per year, now, under this improvement yields an annual rent of from $3000 to $4000. The irrigation is continued at different times, from the 1st of April to the middle of September.

The parties interested in the use of this water for irrigating these lands maintain that the grass produced in these meadows by this process, supports in Edinburgh, 3000 cows, and in Leith 600 cows. It is added that the parties interested in the lands estimate the compensation which would induce them to discontinue the practice, at £150,000, or $750,000. This is stated as the sum which the proprietors at the west side of the city would be entitled to, exclusive of those at the east, were the practice abolished by government."

However small in comparison to Edinburgh, the towns of Georgia may be, still these most extraordinary results are worthy of consideration, and should lead to investigation, for the time must come, and in fact has already come, when the Planters of Georgia must examine and test every source of fertility upon their own soil.

The removal of the sewage, filth and excrements of a city, is second only to the introduction and liberal supply of wholesome water, and should occupy the attention of the agriculturist as well as the consideration and supervision of the Boards of Health, Municipal Authorities, Physicians and Philanthropists.

It has been calculated by European Agriculturists, upon reliable data. "that in a city containing 100,000 inhabitants, there is produced of human manure, 24,440 tons a year, sufficient according to Liebig, to manure 50,000 acres of land, and if conveyed to the soil by irrigation, worth at least £12,000 a year, or $60,000, and probably much more."

Many other sources of fertility accessible to the Planters of Georgia, demand careful consideration ; in the present report we can do nothing more than notice briefly the most important. In subsequent reports these will not only be fully noticed but the results of the most extensive

and reliable European and American experiments will be presented at the same time.

COTTON SEED.

At this late day, no planter needs to be informed that Cotton Seed will compare favorably in its effects with the very best commercial fertilizers. We wish merely to call attention to its chemical constitution, and the best method of preparing it for application to the crop.

The following analyses represent the composition of a sample of the ash of Cotton Seed, submitted to my examination by Mr George Schley, of Augusta. The lot was sent to Mr. Schley from New Orleans, as a sample of what might be furnished in large quantities for fertilizing purposes. Notwithstanding that it was evidently prepared without any special care, the wood with which it was burned, (most probably shingles or boards,) containing many rusty nails; and notwithstanding that a considerable portion of sand was raked up with the ashes, it still yielded 56 per cent. of the Phosphate of Lime and Potassa in a highly soluble state. In fact, the ash of Cotton Seed is capable of yielding more *soluble* phosphates than any other fertilizer offered in the American market.

Ash of Cotton Seed from New Orleans.

ANALYSIS 60. ASH OF COTTON SEED AS RECEIVED.

100 PARTS CONTAIN—

Phosphate of Lime,		22.693
Phosphate of Potassa,		26.177
Chlorides of Sodium & Potassium, 2.119	Sodium & Potassium,	0.872
	Chlorine,	1.347
Sulphates of Potassa & Soda, 3.158	Potassa & Soda,	1 655
	Sulphuric Acid,	1.503
Carbonate of Lime,		1.602
Water chemically combined, Scales of Oxide of Iron, Fragments of rusty nails, Charcoal, Sand, and other impurities,		30.724
Water as moisture,		12 824

ANALYSIS 61. ASH OF COTTON SEED DRIED AT 230° F.

100 PARTS CONTAIN—

Phosphate of Lime,		26.029
Phosphate of Potassa,		30.028
Chlorides of Sodium & Potassium, 2.546	Sodium & Potassium,	0.994
	Chlorine,	1.552
Sulphates of Soda & Potassa, 3.623.	Soda & Potassa,	1.959
	Sulphuric Acid,	1.664
Carbonate of Lime,		1.830

Water chemically combined, Scales of Oxide of Iron, Rusty Nails, Charcoal, particles of brickbats, Sand, and other impurities,	........................35 244

In addition to these analyses, we have before presented the results of the chemical examinations of Cotton Seed by three different chemists—Dr. Ure, Professor Shepard and Dr. Smith.

In the application of Cotton Seed, the planter should act upon the principles which we have established in a former chapter upon immutable ground, viz: that animal and vegetable manures should always be applied, if possible, in their natural condition, and should never be burned under the erroneous idea that the ash alone is valuable.

The organic matters of the Cotton Seed will generate ammonia, and at the same time, during their decomposition the salts will slowly be given out, and supplied to the plants continuously during their growth. The ashes of the Cotton Seed, on the other hand, are readily washed by the rains, below where the roots of the plant can penetrate. It will, therefore, greatly deteriorate if not completely destroy the value of Cotton Seed, as a manure, to burn the organic matters.

We will not dwell longer upon this subject, as we have already devoted an entire chapter to its discussion.

URINE AND EXCREMENTS OF MAN AND ANIMALS.

Unless these be restored to the land, it is evident that it must progressively lose its fertility from the abstraction of certain salts necessary to the growth and perfection of plants. This relation between plants and animals was clearly demonstrated in a previous chapter, and illustrated by elaborate tables, expressing the relations between the constituents of the two kingdoms; and it is unnecessary to dwell longer upon one of the most common and fully acknowledged axioms in agriculture; and we shall content ourselves at present with merely presenting facts which show that all the elements of fertility exist in the excrements of man and animals.

That the excrements of human beings, as well as of animals, are capable of supplying all the material necessary for the development and perfection of all crops, will be readily demonstrated and comprehended by an examination of the following analyses, and the comparison of the results here embodied with the tables before presented, exhibiting the chemical constitution of Wheat, Barley, Oats, Indian Corn, Cotton, Potatoes and other vegetables:

Analysis of Human Fæces, by Berzelius.		*Analysis of Human Urine, by Berzelius.*	
Water,	73.300	Water,	93.30
Insoluble Animal & Vegetable remains,	7.000	Urea,	3.01
Mucus, fatty, and other animal producis,	14.000	Uric Acid,	0·10
Bile,	0.900	Lactic Acid, Lactate of Potash & Ammonia,	1.71
Albumen,	0.900	Mucus,	0.30
Peculiar extractive matter,	2.700	Sulphate of Potash,	0.37
Chloride of Sodium,	0.309	Sulphate of Soda,	0.32
Sulphate of Soda,	0.155	Phosphate of Soda,	0.29
Carbonate of Soda,	0.271	Phosphate of Ammonia,	0.16
Phosphate of Magnesia,	0.155	Chloride of Sodium,	0.45
Phosphate of Lime,	0.310	Chloride of Ammonia,	0.15
	100.000	Phosphate of Lime & Magnesia,	0.11
Percentage of Ash,	1·200		100.00

Analysis of the Ash of Human Fæces, by Berzelius.		*Analysis of the Ashes of the Fæces of a Horse, by Jackson.*		*Analysis of the Ashes of the Fæces of the Cow, by Haiden.*	
Phosphate of Lime, Phosphate of Magnesia & Gypsum,	66.66	Phosphate of Lime,	5.00	Phosphate of Lime,	10.9
Sulphate of Soda, Sulphate of Potash, Phosphate of Soda,	5.53	Carbonate of Lime,	18.75	Phosphate of Magnesia,	10.0
Silicic Acid,	10.66	Phosphate of Magnesia & Phosphate of Soda,	36.25	Silicic Acid,	63.7
Carbon and Loss,	12.00	Silicic Acid,	40.00	Phosphate of Iron,	8.5
				Lime,	1.5
				Gypsum & Chloride of Potassium,	3.1
				Carbon and Loss,	1.3
					100.00

We have before recommended the use of swamp deposits, and also demonstrated by chemical analyses their great agricultural value. Providence has placed at the disposal of the planter, in the deposits of swamps and forests, the means of restoring to his lands far more than what is yearly sent off in the form of Cotton, Wool, Grain and Cattle. The great problem of agriculture—the maintenance of an equilibrium—the maintenance of the soil in a state of permanent fertility, thus finds its solution in Georgia.

Use lime as the basis of all permanent agricultural improvement· Save and apply every pound of manure.

In addition to this, supply the yearly waste which goes on over and above the manure returned, by the deposits of swamps and forests.

In this connection, we cannot refrain from presenting to the Convention the following Essay on Making Compost Heaps, which received not only the sanction but the prize of one of the most enlightened and learned Agricultural Societies in the world.

Prize Essay on making Compost Heaps from Liquids and other Substances; written from the evidence of many years experience. By James Dixon, Esq.*

The force and power of an agriculturist to produce good crops mainly depend on the manures he can command, and how to derive the greatest possible amount from his immediate resources is one of the most useful subjects that can engage his attention. The English Agricultural Society having offered a premium for the best mode of making compost heaps, I venture to forward the committee my ideas on this most important branch of rural management; and in doing this, I shall state the course I have pursued in this particular for many years, and in which every additional experience inclines me not to make any systematic alteration.

My farm is a strong retentive soil, on a substratum of ferruginous clay; and being many times disappointed in what I considered reasonable anticipations of good crops, I determined on a new system ot manuring. Though quite satisfied of the expense which would necessarily be incurred by my plan, I still determined on its adoption. At the onset I effectually drained a considerable part of my farm.

My next object was how to improve its texture at the least cost (perhaps I may be allowed to state that my holding has always been at rack rent). For this purpose we carted great quantities of fine saw-dust and peat earth or bog; we had so far to go for the latter, that two horses would fetch little more than three tons in one day—one horse would fetch three cart loads of saw-dust in the same time.

Having brought great quantities of both peat and saw dust into my farm yard, I laid out for the bottom of a compost heap a space of considerable dimensions and about three feet in depth; three-fourths of this bottom was peat—the rest saw dust; on this we conveyed *daily* the dung from the cattle sheds; the urine also is conducted through channels to wells for its reception—one on each side of the compost heap; common water is entirely prevented from mixing with it. Fvery second day the urine so collected is thrown over the whole mass with a scoop, and at the same time we regulate the accumulated dung. This being continued for a week, another layer, nine inches or a foot thick, of peat and saw dust (and frequently peat without saw dust) is wheeled on the accumulated heap. These matters are continuously added to each other during the winter, and in addition once in every week never less than 25 per cent, more frequently 50 per cent. of night soil and urine; the latter are always laid next above the peat or bog earth, as we think it accelerates their decomposition. It is, perhaps, proper here to state that the peat is dug and exposed to the alterations of the weather for several months before it is brought to the heap for admixture; by this it loses much of its moisture. In some cases peat contains acid or astringent matters, which are injurious to useful vegetation. On this I have not tried any decided experiment, but am led to the supposition by frequently seeing stones, some in a partial state of decomposition, others wholly decomposed, in bogs, and at the depth of several feet from the surface. Several years experience has convinced me of the impropriety of using recently dug peat; proceeding in the manner I recommend, it is superior and more convenient on every account—very much lighter to cart to the farm yard, or any other situation where it is wanted; and so convinced am I of its utility in composts for every description of soil, except that of its own character, that, wherever it can be laid down on a farm at less than 4s. per ton, I should recommend every agriculturist and horticulturist who can command it, even at the cost here stated, to give it a fair trial. So retentive and attractive of moisture is peat, that, if liberally applied to an arid sandy soil, that soil does not burn in a dry season; and it so much improves the texture and increases the produce of an obdurate clay soil, if in other respects rightly cultivated, that actual experience alone can fairly determine its value.

For the conveyance of night soil and urine, we have the largest and strongest

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* Journal of the English Agricultural Society, vol. 1, p. 135.

casks, such as oils are imported in; the top of which are provided with a funnel to put the matters through, and the casks are fixed on wheels like those of a common dung cart. For the convenience of emptying this carriage, the compost heaps are always lower at one end; the highest is when we discharge the contents, in order that they may in some degree spread themselves over the whole accumulation: the situation on which the wheels of these carriages stand while being discharged is raised considerably; this we find convenient, as the compost heaps may be sloped six or seven feet high—low compost heaps, in my opinion, should be avoided. The plan here recommended I have carried on for some time. I find no difficulty in manuring my farm over once in two years; by this repetition I keep up the fertility of my land, and it never requires more than a moderate application of manure. I am fully aware that there are many localities where neither peat nor night soil can be readily obtained; but it is worth a farmers while to go even more than twenty miles for the latter substance, provided he can have it without deterioration; the original cost is often trifling. On a farm where turnips or mangold are cultivated to some extent, the system here recommended will be almost incalculably advantageous; a single horse is sufficient for one carriage—mine hold upwards of a ton each; 6 tons of this manure in compost with peat, or, if that is not convenient, any other matters, such as ditch scourings, or high headlands which have been properly prepared and laid dry in a heap for some time would be amply sufficient for an acre of turnips or mangold. This manure is by far the most invigorating of any that I have yet tried; bones in any state will bear no comparison with it for any crop; but it must be remembered that I write upon the supposition that it has not been reduced in strength before it is fetched.

Convenience frequently suggests that compost heaps should be raised in different parts of a farm; but unless in particular instances, it is well to have them in the yard; in the farm yard all the urine from the cattle stalls may be employed with the greatest economy; and be it remarked that the urine from animals in given weights is more powerful than their solid excrements. How important then must it not be to the farmer to make the most extensive and most careful use of this liquid! It is sometimes carted on the land, but that practice will not bear a comparison with making it into composts in the manner here recommended. Great waste is often made in putrescent manures after they are carted on the land; instead of being immediately covered or incorporated with the soil, we not unfrequently see them exposed for days together in the hot rays of a scorching sun, or to the injurious influences of a dry wind. I have before stated that compost heaps should on many considerations be raised in the farm yard; still, circumstances are frequently such that it is more proper to make them at some distance in the fields; if a head land becomes too high by frequent ploughings or workings of the land, in that case it should be ploughed at the time when clover or mixed grass seeds are sown with a white crop; for instance, barley or oats, and clover for the year following; a headland might then be ploughed, and a number of cart loads of some manure heaped from one end to the other. Immediately after this, it should be trenched with the spade (or what is sometimes called digging) and ridged high, in order that an action should take place between the soil and the manure; by this means the mass would soon be in a condition for turning over, and any ditch scourings or other matters which had not in the first instance been used, might now be added to the mixture. The heap should then be allowed to remain closed for a few weeks, then turned over again; at this turning in all probability the mass would be much reduced; if sufficiently reduced, raise the ridge of compost well on both sides, but instead of its top being pointed, make a trench or cavity on the top from one end of the heap to the other. This cavity should be made tolerably retentive of moisture, which may be effected by treading with the feet; carriages of night soil and urine from the cattle stalls may then be emptied into the trench and the bulk of the heap would determine how many were required; this being done, a little earth should be thrown into the trench and the heap allowed to remain in that state until the middle or last of the autumn; it will then be ready for another turning; but at this time care must be taken to have the heap well made up at the sides and pointed at the top; in this situation rain will be thrown

off, and the compost preserved dry until the winter presents some favorable opportunity for laying it on the young clover, wheat, or for making any other use of it which may be required.

The beneficial effects of top dressing young clovers or mixed grass seeds is scarcely ever regarded with due attention. By this help crops are not only much increased, even 30 or 50 per cent., but they are also ready much sooner, which, in a backward spring, gives the stock farmer inestimable advantages for sorting his cattle, and thereby raising manure at his pleasure. The full effects of this practice I first experienced in the dry season of 1826. I had some clovers which had been manured the previous winter; my land was soon covered with crop, and that so vigorous a one, that the hot weather did not over-power it. My cows that summer were tied up during the day-time, and at night turned out into pasture: most of the stock in my district were much distressed from over-heat, as well as being short of food for some weeks; milk yielded little butter, scarcely any for a time was offered in our large market town. No doubt that year will be remembered by many gentlemen on the Agricultural Society's committee. I, however, was under no difficulties on account of the season; my clovers produced plenty of food for my cattle, and, in return, they yielded as much milk and butter as I ever recollect from the same number.

I am persuaded that the same satisfactory results would have followed if the same system had been adopted for feeding stock; it was that year my attention was first directed tc raising compost heaps from urine. This I now do frequently without the help of any dung from the catt:e stalls. The same occasion called my mind to another matter well worthy the farmers attention. I allude to the great superiority of the manure raised in summer soiling to that produced in the stalls during the winter. I verily believe the difference is 50 per cent., unless stock are fed in a great measure during winter with artificial food. For an arrangement for making compost heaps from urine, I would recommend a receptacle to be made at the back of the stable just outside the building; this should hold about 20 cart loads of mould, or any other matters to be employed. If its situation were a little lower than the cattle sheds, all the urine would pass into it, and remain there until the mass is completely saturated, which will be sufficient. When the earthy matters are covered over with it, the compost may then be thrown out and the proceeding again renewed. In order to show part of the benefits of this practice, I beg here to observe that the most foul or weedy mould may be used. The action of the urine, if not reduced by water, is so powerful that wire worms, the black slug, many other destroying insects, and all vegetable weeds, &c., when in contact with the urine for a time, lose their living functions. The situation for raising this compost should be protected from the weather by a covering similar to a cart shed; indeed, the deteriorating influences of sun, rain and winds on all putrescent manures or compost are so serious that in my humble judgment it would be worth while to have places under cover where these are usually laid down.

The ordinary way of conveying manures on land admits of much improvement. I am now preparing carriages and a movable railway for this purpose. Where compost is raised in the field, I am confident that I shall be able to save 100 per cent. in time, and also a very considerable one in expense. Not having my designs yet in actual operation, I cannot at present show any practical results. At no distant time this shall be the subject of another paper. The system here alluded to I have in a forward state of preparation; also other matters for improving a deficient texture.

I beg to conclude this essay with some observations made on a former occasion. No amelioration connected with the rural art is of more lasting importance than correcting the constitutional defects of a soil. The best horticulturists and market gardeners are many of them, perhaps, unacquainted with the theory, yet perfectly understand the great results from that practice; and in this particular information, are superior to many practical farmers. How often do we see a stiff soil sterile in a great degree from that cause only; yet in the vicinity of a sand pit and adjoining most bogs there is a considerable breadth of coherent land, which might be made double its present value by judicious and liberal top dressings of peat, which is also unproductive from causes of an opposite nature.

The present poverty of many extensive tracts of land is a manifest exhibition of the want of skill or enterprise of their owners and cultivators.

Principles which should govern the Collection and Preeservation of the Excrements of Man and Animals, and the Products of Decomposing Vegetables.

The valuable compound Ammonia, which results from the decomposition of the insoluble and soluble animal and vegetable remains of human and animal fæces, and from the decomposition of the urea, uric acid, coloring and extractive matters of human and animal manures, and from the decomposition of the nitrogenized matters of vegetables, is both volatile and soluble.

The rays of the sun will cause the ammonia to escape into the surrounding atmosphere; whilst the rains, on the other hand, will dissolve and wash away this valuable ingredient. Caustic lime added to manure of any kind, animal or vegetable, will cause the ammonia to escape under any circumstances, whether it be exposed to the full blaze of the sun and the washing of every rain, or be carefully covered and excluded from both causes of dissipation.

It is evident, therefore, that the planter should carefully exclude his manure heaps from the direct rays of the sun, and from the washing of the rain, and never apply caustic lime directly to his manure heaps.

2. Under any circumstances, and even when the manure is carefully protected from the sun and the rains, the ammonia will, to a certain extent, escape into the surrounding atmosphere. This escape is always attended by a deterioration of the value and efficacy of the manure. It s desirable, therefore, to have some easy and cheap mode of rendering he ammonia stable, and of retaining it in the manure. This may be accomplished in various ways; we will state the best and most efficacious.

Finely divided charcoal scattered over the manure pile and in the stables and cow-pens, every day, will absorb the ammonia, and at the same time deodorize the excrements to a great extent.

The mineral acids, Sulphuric, Nitric and Hydrochloric acids, diluted and sprinkled over the manure, will combine with the volatile ammonia, and convert it into stable and at the same time soluble salts, of the greatest value in agriculture.

3. The salts of the fæces, and urine, and of vegetables, are highly soluble, and are therefore washed away by rains.

Manure exposed to the action of the sun and washing of the rains, loses both its ammonia and its salts, which alone render the manure valuable.

4. The urine, the fluid portion of the manure, is proportionally far more valuable, as we have just shown in the analyses, than the fæces.

If, therefore, the manure be collected and preserved upon the ground, the most valuable fluid ingredients will be absorbed by the ground to a greater or less extent, according to the structure of the soil, and the value of the manure will be proportionally diminished.

5. Guided by the foregoing well established facts and principles, the following plan is at once suggested to the planter:

Plan for the effectual Preservation of the Valuable Ingredients of Manure.

a. The manure should always be collected and preserved under cover, sufficiently close to exclude the direct rays of the sun, and the rains.

The expense of erecting sheds over hog-pens, cow-pens, sheep-pens, mule-pens, and over manure piles, will be repaid one thousand fold by the increased value of the manure.

b. The surface upon which the manure rests should be water proof, and should be so arranged that the fluid portions may, when necessary, be drained off, and either added to the field in this state, or poured over the manure in mass.

c, The ammonia should be fixed by the use of diluted Sulphuric, Hydrochloric and Nitric acids. The commercial acids may be purchased at from 2 to 5 cents per pound.

Four pounds of any one of these acids should be dissolved in a barrel of water, and this should be scattered over the pens in which the manure is being made, and over the manure piles, every morning after the cattle and horses and mules have been turned out; then a layer of dry trash should be spread over the wet surface. To accomplish this we would require, for a medium sized place, say one of 30 working hands, with the usual proportion of horses, mules, oxen and cattle, upon our Georgia plantations, 1250 pounds of acid. This, at 5 cents per pound, would cost $63. This amount of acid would be capable of fixing more than an equal amount of ammonia, and if we assume that this element is worth 14 cents per pound, then in this respect alone, the increased value of the manure would be at the lowest calculation $174, besides the value of the acids themselves, which is greater in an agricultural than a commercial point of view; we may, therefore, safely affirm that the value of each pound of acid will be increased three fold.

d. If the acids cannot be obtained, then pulverized charcoal should be scattered over the manure every morning.

e. Gypsum, when it can be obtained at reasonable prices, may also

be used as a valuable means of fixing the ammonia. When scattered over the manure piles and mixed with the fermenting excrements, the ammonia combines with the sulphuric acid of the gypsum, and is thus fixed.

We feel confident that one load of manure, made upon the plan with the acids, will be worth at least six loads of the manure now prepared by the great majority of the planters of Georgia.

The following principles are so well established, and so simple and self-evident to the most casual observer, that it would almost appear to be a work of supererogation to urge them upon the planters of Georgia.

Many other sources of fertility, as native beds of Gypsum, Feldspar, Green Sand, deposits of Salt Marshes, and various indigenous vegetables, as the Black Rush, demand careful examinations; but they must necessarily, from the amount of labor necessary for thorough investigations, be deferred to subsequent reports.

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